THESIS FOR THE AWARD OF DEGREE OF

MASTER OF SURGERY

SESSION 2022-2025

APPLICATION OF PRINCIPLES OF ENHANCED RECOVERY AFTER SURGERY VERSUS CONVENTIONAL RECOVERY IN ABDOMINAL SURGERIES: RANDOMIZED CONTROLLED TRIAL

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ACKNOWLEDGEMENT

First and foremost, I extend my heartfelt appreciation to my family, whose unwavering love, patience, and belief in me have been a constant source of strength and encouragement. Their support was instrumental, especially during the most challenging phases of this journey.

I am deeply grateful to my mentor and guide, Dr. Shalabh Gupta, whose exemplary guidance, encouragement, and insightful feedback has shaped every stage of this research. His mentorship extended far beyond academic supervision, serving as a source of inspiration and intellectual growth.

A special note of gratitude goes to Dr. Naveen Kumar Solanki, Dr. Akshita Gupta, and Dr. Amit Kumar for their constant support, clinical guidance, and encouragement throughout my postgraduate training in General Surgery. Their mentorship has played a vital role not only in this thesis but also in shaping my professional journey.

My sincere appreciation goes to Dr. Hari Mohan for his valuable suggestions and steadfast support during the research process.

I am also thankful to all my respected seniors, dear juniors, and the dedicated staff of the Department of General Surgery, whose support, both academic and personal, greatly contributed to this work.

I gratefully acknowledge the constant encouragement and motivation received from my colleagues Dr. Vidushi Bhardwaj, Dr. Shalu Yadav, Dr. Santosh Kumar Sahni, Dr. Ravi Shankar, Dr. Abhinav Patel, Dr. Komal Kumar Sharma, Dr. E Ujwal, Dr. Jai Khalyav, and Dr. G Pruthvi. Their camaraderie and support has made this journey memorable.

I’m extremely thankful to all the patients who willingly participated in this study. Despite facing personal health challenges, they demonstrated exceptional cooperation and trust. Their contribution forms the foundation of this research, and I wish them all a swift recovery and good health.

Last but not the least, I thank almighty for his benevolence and blessings.

INDEX

S. No.	Content	Page No.
1.	INTRODUCTION	1-2
2.	AIMS & OBJECTIVES	3
3.	REVIEW OF LITERATURE	4-36
4.	MATERIALS & METHODS	37-40
5.	OBSERVATIONS & RESULTS	41-52
6.	DISCUSSION	53-61
7.	CONCLUSION	62-63
8.	SUMMARY	64
9.	BIBLIOGRAPHY	65-80
10.	ANNEXURES	81-91

LIST OF ABBREVIATION

BIA	Bioelectrical Impedance Analysis
CHL	Carbohydrate Loading
COX	Cyclooxygenase
CO_2	Carbon Dioxide
CRP	C-Reactive Protein
CWI	Continuous Wound Infiltration
EBWL	Excess Body Weight Loss
EEN	Early Enteral Nutrition
EL	Emergency Laparotomy
EN	Enteral Nutrition
ERAS	Enhanced Recovery After Surgery
GDFT	Goal-Directed Fluid Therapy
GE	Gastroesophageal
GI	Gastrointestinal
HES	Hydroxyethyl Starch
HRT	Hormone Replacement Therapy
ICU	Intensive Care Unit
LBM	Lean Body Mass
LIA	Local Infiltration Analgesia / Anaesthesia
MBP	Mechanical Bowel Preparation
MIC	Minimum Inhibitory Concentration
MIC90	MIC at which 90% of bacteria are inhibited
MRSA	Methicillin-Resistant Staphylococcus Aureus
MS	Motion Sickness
NERAS	Non-Enhanced Recovery After Surgery
NGT	Nasogastric Tube
NMJb	Neuromuscular Junction Blocker
NPO	Nil Per Oral (nothing by mouth)
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs

NaP	Sodium Diphosphate
OCP	Oral Contraceptive Pills
POD	Postoperative Day
PONV	Postoperative Nausea and Vomiting
RCT	Randomized Controlled Trial
SSI	Surgical Site Infection
TIVA	Total Intravenous Anaesthesia
TPC	Traditional Postoperative Care
VTE	Venous Thromboembolism
WBC	White Blood Cell
WI	Wound Infiltration

ABSTRACT

Introduction:

Enhanced Recovery After Surgery (ERAS) is a multidisciplinary, evidence-based approach to perioperative care aimed at minimizing surgical stress and promoting faster recovery. It integrates proven strategies into clinical pathways to enhance functional outcomes through incremental improvements. By preserving preoperative organ function and attenuating the postoperative stress response, ERAS reduces morbidity, complications, hospital stay, healthcare costs, and patient discomfort. Compared to conventional care, it represents a significant advancement in surgical recovery. However, implementation can be challenging due to variations in perioperative practices. The four core components of ERAS include: 1) Preoperative counselling, 2) Nutritional optimization, 3) Standardized analgesia and antibiotic use, and 4) Early mobilization.

Aims & objectives:

This study aims to compare ERAS protocols with conventional recovery in abdominal surgeries through a randomized controlled trial. It assesses patient parameters preoperatively, intraoperatively, and postoperatively until discharge. The study also reviews current practices and challenges in ERAS implementation. The objective is to reduce surgical stress, complications, hospital stay, and enhance recovery.

Methodology:

This randomized controlled trial was conducted in the Department of General Surgery, Santosh Medical College, Ghaziabad, over 1.5 years. A total of 278 patients (139 in each group) undergoing elective abdominal surgeries were enrolled. Inclusion criteria were age 18–80 years and both sexes; emergency and immunocompromised cases were excluded.

Randomization was performed using the NCI Clinical Trial Randomization Tool. Patients were assessed for day of mobilization, feed tolerance, wound healing, investigation findings, and quality of life. Data were entered in MS Excel and analysed using Stata MP-17 software. Appropriate statistical tests were applied based on data distribution, with $p < 0.05$ considered significant. Chi-square test, t-test, and correlation analysis were used to assess outcomes between groups.

Results:

The ERAS group demonstrated clear advantages over the NERAS group across multiple recovery parameters. Patients receiving ERAS care experienced earlier mobilization, quicker initiation and tolerance of oral and solid diets, and faster return of bowel function. The use of carbohydrate loading was exclusive to ERAS, while bowel preparation and surgical drains were used less frequently. Although the incidence of postoperative nausea and vomiting was similar in both groups, overall recovery was smoother and more rapid in the ERAS cohort, highlighting the effectiveness of enhanced recovery protocols.

Conclusion:

This study confirms that implementing Enhanced Recovery After Surgery (ERAS) protocols in abdominal surgeries leads to significantly improved postoperative outcomes compared to conventional care. Key components such as carbohydrate loading, minimal bowel preparation, multimodal analgesia, early feeding, mobilization, and gut stimulation were associated with faster recovery and reduced complications. ERAS patients showed earlier tolerance to feeding, quicker return of bowel function, and less reliance on drains, with a trend toward fewer PONV cases. These improvements were not influenced by baseline demographics, highlighting the protocol's effectiveness. The findings support ERAS as a safe, feasible, and superior perioperative strategy. Wider adoption and future large-scale studies are recommended to establish standardized ERAS protocols across surgical specialties.

Keywords:

Enhanced Recovery After Surgery (ERAS), Conventional Recovery (NERAS), Abdominal Surgeries, Randomized Controlled Trial (RCT), Perioperative Care, Surgical Stress, Multimodal Analgesia, Early Mobilization, Carbohydrate Loading, Selective Bowel Preparation, Early Oral Feeding, Solid Diet Tolerance, Gut Motility Stimulation, Postoperative Recovery, Postoperative Nausea and Vomiting (PONV), Surgical Drains, Functional Recovery, Hospital Stay, Complication Rates, Quality of Life, Evidence-Based Protocols.

INTRODUCTION

Enhanced recovery after surgery (ERAS) is a multidisciplinary approach to perioperative care with evidence-supported measures that aim to reduce surgical stress and accelerate postoperative rehabilitation. [1]

The concept of enhanced recovery after surgery (formerly 'fast track surgery') was introduced by Danish surgeon Professor Henrik Kehlet in 1997. Kehlet suggested that 'while no single technique or drug regimen has been shown to eliminate postoperative morbidity and mortality, multimodal interventions may lead to a major reduction' and went on to suggest pre-, intra- and post-operative surgical risk factors that may be addressed through coordinated perioperative protocols.[3]

Its pathways incorporate evidence-based strategies into care plans with the goal decreasing reducing patient surgical stress response and accelerating functional recovery through aggregation of incremental improvements. This can be achieved by maintaining pre-operative organ function and reducing the profound stress response following surgery. [2]

Prof Henrik Kehlet also published results that were sensational at the time, showing that elderly patients undergoing colonic resections could recover and be fit for discharge in 2 days when the norm recovery time was at least 2 weeks. By changing the name of the concept from Fast Track where the focus in the reporting had been length of stay implying that the target being fast discharge of the patient now changing to Enhanced Recovery the focus was clearly directed to the patient and his/her recovery.[4]

In 2001 came the formation of the Enhanced Recovery After Surgery (ERAS) Study Group—a group of six surgeons assembled by Professors Ken Fearon and Ollie Ljungqvist and including Professor Kehlet, which aimed to produce and interpret the best available evidence to fine-tune fast track surgery.[3]

The ERAS Study Group did the first literature review on best care for perioperative management in colonic resections and what was to be the forerunner to ERAS Guidelines. [4]

ERAS protocols are used to modify surgical stress responses after any surgery. Compared with the traditional perspective, the ERAS pathway is the new revolution for surgery, as it significantly decreases morbidity, surgical complications, hospital stay, overall medical charges & patient discomfort, helps improve quality of care provided to the patient & results in enhanced recovery. However, these protocols are not straightforward to implement as peri-operative care is varied.

The 4 key elements of ERAS:-

1. Pre operative counselling
2. Optimisation of nutrition
3. Standardised analgesics and optimal use of antibiotics
4. Early mobilization.

AIMS AND OBJECTIVES

AIMS: -

Application Of Principles Of Enhanced Recovery After Surgery Versus Conventional Recovery In Abdominal Surgeries: Randomized Controlled Trial.

Objective: -

1)To observe various parameters of the patients at 4 levels:-

- 24 hours before surgery
- Intra operative period
- After surgery - before discharge

2) To review current practice, methods and issues in implementing ERAS which will help reduce the stress response to surgery, minimize complications, shorten hospital stays, and enhance recovery.

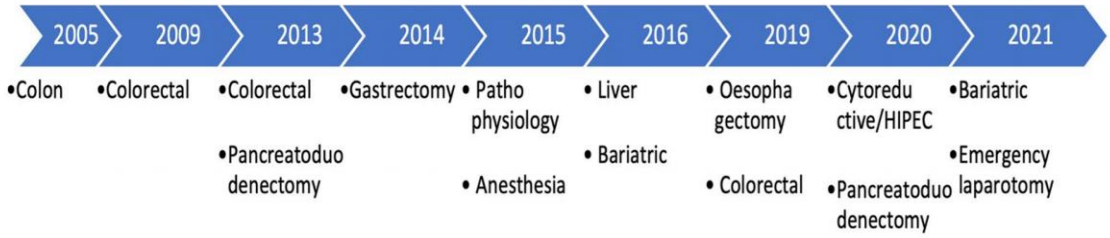
REVIEW OF LITERATURE

The goal of modern medical treatment is to provide high quality medical care in a cost-effective environment. [5] Enhanced Recovery After Surgery (ERAS) is an evidence-based paradigm shift in perioperative care, proven to lower both recovery time and postoperative complication rates. The role of ERAS in several surgical disciplines was reviewed. In colorectal surgery, ERAS protocol is currently well established as the best care. [6]

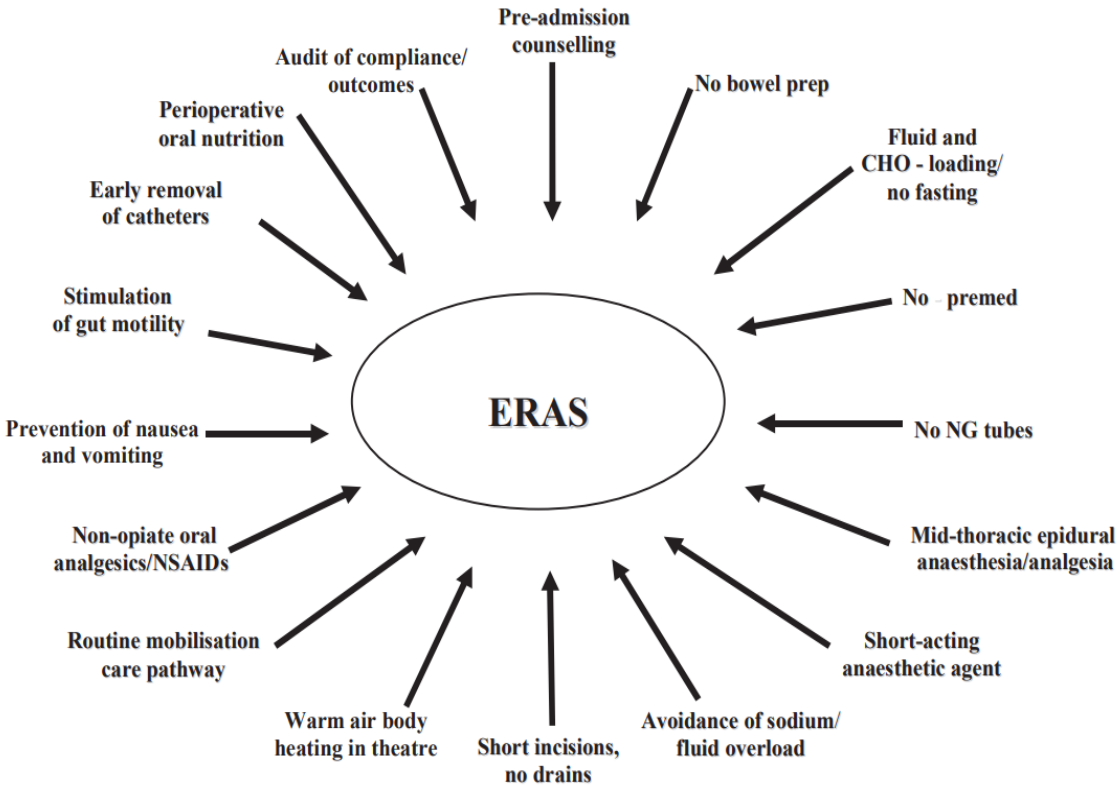
The concept rested on several components: a multidisciplinary team working together around the patient; a multimodal approach to resolving issues that delay recovery and cause complications; a scientific, evidence-based approach to care protocols; and a change in management using interactive and continuous audit. [7] ERAS success in different patient populations was analysed, and it was found that in the elderly population, ERAS shortened the length of hospitalization and did not lead to a higher risk of postoperative complications or readmissions. Inspired by Danish Professor of surgery Henrik Kehlet, ERAS protocol questioned traditional perioperative care including: prolonged fasting, mobility limitations, mechanical bowel preparation, routine use of drains, and the slow return to eating normally postoperatively. Kehlet theorized that the avoidance of such perioperative doctrine shortens the length of hospitalization by reducing the metabolic stress, fluid overload, and insulin resistance placed on the body. [6]

The Enhanced Recovery After Surgery (ERAS) protocol was developed by a group of academic surgeons in Europe in 2001 when they formed the ERAS Study group. [7]

Enhanced recovery guidelines for gastrointestinal surgery [8]



Main elements of the ERAS protocol [9]



Goals of ERAS

- **Reduce hospital stays**: To reduce the length of hospital stays and lower costs.
- **Reduce complications**: Reduce the risk of postoperative complications and readmissions.
- **Reduce recovery time**: Reduce recovery time and facilitate a return to baseline function.
- **Improvement in functional recovery**: ERAS aims to promote earlier return to baseline activity levels.

Components of Enhanced Recovery After Surgery [10]

Preoperative [10]

- Preoperative counselling
- Smoking cessation and alcohol use stopped 4 weeks before surgery
- Anaemia investigated and treated
- HRT and OCP stopped
- Nutritional counselling and assessment; carbohydrate loading
- Avoidance/ selective bowel preparation

Intraoperative [10]

- Use of antibiotics
- Maintaining normothermia
- Maintaining euvolemia

Postoperative [10]

- Extended VTE prophylaxis
- Multimodal analgesia
- PONV prophylaxis
- Avoidance of nasogastric suction and intraabdominal drains
- Active mobilization
- Removal of urinary catheter
- Early feeding with high protein diet

Note: HRT = hormone replacement therapy, OCP = oral contraceptive pills, VTE = venous thromboembolism.

1. **Preadmission information, education and counselling**

Proper and complete information may reduce anaesthesia- and surgery-related anxiety and subsequent pain. [11]

- Risk assessment

  Control of systemic diseases such as optimisation of heart disease, lung disease, kidney disease, hypertension, diabetes, correction of derangements such as anaemia and malnutrition, and cessation of excessive alcohol use and smoking. [11]

- Smoking cessation

  Patients who smoke have an increased risk of intra- and postoperative complications.

  4–8 weeks of abstinence appear necessary to reduce respiratory and wound-healing complications. [11]

- Avoiding Alcohol Abuse

  Observational studies suggest that alcohol abuse increases postoperative morbidity. [11] A systematic review and meta-analysis identified thirteen observational studies and five RCTs and showed that consumption of more than two units (equal to a total of 50 ml spirits 40%, 150 ml wine 13%, 500 ml 4% beer or alcopop (a ready-mixed drink containing alcohol) of alcohol per day increases the rate of postoperative infections, but not mortality. Preoperative abstinence of 4 weeks is recommended.[12]

Prehabilitation

Prehabilitation is defined as ‘‘A process in the continuum of care that occurs between the time of diagnosis and the beginning of acute treatment (surgery, chemotherapy, radiotherapy) and includes physical, nutritional and psychological assessments that establish a baseline functional level, identify impairments, and provide interventions

that promote physical and psychological health to reduce the incidence and/or severity of future impairments. [13] The primary goal of prehabilitation is to prevent or reduce the severity of anticipated treatment-related impairments that may cause significant disability. [13]

2. PREOPERATIVE OPTIMIZATION

I. Avoidance of Prolonged Fasting & Carbohydrate Loading

Pre-operative nil per oral (NPO) is a common practice to minimize the chance of aspiration throughout the perioperative period. However, preoperative fasting results in shrinkage of intravascular volume and affects the internal milieu of the patient, which clinically manifests as tachycardia, hypotension, decreased stroke volume and cardiac output of the patient. [14] Administration of anaesthetic agents additionally affects the hemodynamic of the patient. Once these two factors are combined, it causes vital alteration and results in hemodynamic instability. Prolonged fasting preoperatively leads to enhanced catabolic metabolism, muscle breakdown, insulin 2 resistance, and hyperglycaemia. [15]

Elective surgery leads to a transient increase in insulin resistance, which is highest on the first postoperative day, is proportional to the magnitude of the trauma, and lasts for approximately 2–3 weeks. [16] During insulin-resistant states, glucose uptake by the cells is decreased and consequently glycogen formation stops, and glycogen stores in the liver and muscles are depleted. Prolonged preoperative fasting may lead to increases in the inflammatory markers of the acute-phase response after surgery, and CHO-rich oral supplements 2–3 h before surgery may attenuate the response. [16]

As nutrients are consumed and the body moves from the fasted to fed state, insulin is released to accommodate nutrient storage. With the release of insulin and glycogen preservation, an individual achieves an anabolic state, the desired state, for a patient about to endure a surgical procedure. [16] Randomized controlled trials (RCTs), systematic reviews and meta-analyses have shown that carbohydrate loading before surgery increases insulin sensitivity, reduces postoperative inflammation, decreases length of hospital admission and improves patient-reported outcomes. [11,10,17]

A recent meta-analysis has investigated that compared with fasting, preoperative administration of carbohydrates decreased patients' thirst, hungry, and pain. [18] The idea of pre-operative carbohydrate loading is recently introduced to avoid unfavourable effects of prolonged fasting. The most recent literature is in favour and showed lesser side-effects, better pain control, and improved insulin sensitivity. [14]

II. Avoidance/ Selective Bowel Preparation

The stated goal of MBP is to completely empty the bowel before surgery in order to decrease the risk of infectious complications. This is conventional wisdom and is theoretically accomplished by decreasing the bacterial load in the intestinal lumen and by decreasing the risk of spillage of faeces in the operative field. [19]

Mechanical bowel preparations (MBP) was thought to clear the bowel lumen of stool and leave only gas. This would decrease the intralumenal pressure of hard, potentially impacted stool, and reduce ischemia at the new anastomosis. In laparoscopic surgery, an empty colon may be easier to manipulate than a colon full of stool. [20]

However, in recent years, the necessity and benefits of a MBP have been questioned and data supporting abandonment of this practice is mounting. [20]

When MBP is performed alone, the bacterial load does not decrease significantly in the lumen or in the bowel wall. [19] The intervention that affects changes in bacterial flora is the use of antibiotics, not the bowel preparation.[19]

There are many choices for preparation of the bowel before elective surgery, which include various preparations of PEG, bisacodyl tablets, aqueous and tablet sodium diphosphate (NaP), and saline laxatives. [21]

However, current methods of mechanical bowel preparation rarely provide a completely "clean" bowel, but instead it was seen that MBP liquefies the solid faeces often resulting in fluid bowel contents. [22]

Overall, patients receiving mechanical bowel preparation had a tendency toward a higher incidence of bowel contents spillage compared with patients who did not have mechanical bowel cleansing. There was a tendency toward a higher rate of

postoperative surgical infectious complications, including wound infection, intra-abdominal abscess, and anastomotic leak, when spillage of bowel contents occurred during surgery. [22]

It had been shown by various authors that although MBP does cause reduction in the fecal mass in colon, it does not cause any significant reduction in the concentration per milliliter of the bacterial count in the lumen of the colon in the absence of prophylactic antibiotics. Thus on its own MBP has no beneficial value. [23,24]

Further it had been also seen that histological changes occur in the intestinal mucosa of patients who have received MBP. There was also significant loss of epithelial cells, edema of lamina propria, lymphocytic and polymorphonuclear cell infiltration in these patients. These changes could potentially result in bacterial translocation and anastomotic disruption. [25,26]

Besides this, MBP has many negative side effects, like discomfort to patients and water and electrolyte imbalance, and is also not safe for elderly patients and those having underlying cardiac, renal or pulmonary disease. [27]

III. Antibiotic Prophylaxis

Surgical site infection is defined as a nosocomial infection that occurs at or near a surgical incision or operative site within 30 days of surgery, or within 90 days if a prosthetic device is implanted during the procedure. [28] SSIs can present as superficial infections affecting the skin and subcutaneous tissues, deep infections involving the fascial and muscle layers, or organ/space infections that affect any part of the body other than the incision site. These infections are typically marked by local signs of inflammation such as redness, swelling, heat, and discharge of pus, and may also be accompanied by systemic symptoms, including fever and elevated white blood cell count. [29,30]

Surgical site infections (SSIs) remain a significant concern in the field of surgery, contributing to patient morbidity, prolonged hospital stays, and increased healthcare costs. Antibiotic prophylaxis, the administration of antibiotics before surgery, has been a cornerstone in preventing SSIs for decades. [31]

Currently, the use of preoperative antibiotic prophylaxis has significantly decreased the incidence of surgical site infections. [32]

Preoperative antibiotic prophylaxis is administering antibiotics before performing surgery to help decrease the risk of postoperative infections. The timing of antibiotic administration may vary, but the goal of administering preoperative systemic prophylactic antibiotics is to have the concentration in the tissues at its highest at the start and during surgery. The literature supports at least 30 minutes, but no greater than 60 minutes before the skin incision is made to the optimal timing for the preoperative administration of most commonly used antibiotics.[33]

Selection of antibiotics should thus be based on the most likely pathogens. The most common organisms implicated as causes of surgical site infections include [34]:

- Staphylococcus aureus
- Staphylococcus epidermidis
- Aerobic streptococci
- Anaerobic cocci

The parameters that are necessary to accurately assess antibiotics for the best window of application to minimize post-surgical infections include tissue half-life, minimal inhibitory concentration, and redosing interval. Half-life is the amount of time required for the plasma concentration of the drug to reduce by half. However, tissue concentration is more specific for surgical infections. [32]

The minimal inhibitory concentration (MIC) is the concentration of antibiotics at the site of infection that inhibits bacterial growth. The MIC90 is the MIC at which 90% or more of bacteria are inhibited. Furthermore, dosing interval is important to maintain a bactericidal level of antibiotics in the system and has been shown to be neglected. The dose interval is 1-2 times the half-life of the drug and is measured from the time of administration rather than the start of the procedure. [32]

Currently, a first or second-generation cephalosporin (cefazolin or cefuroxime) remains the routine perioperative antibiotic regardless of the type of surgery (revision or primary), comorbidity, or immune status. [34]

Vancomycin is only recommended in patients who are chronic methicillin-resistant Staphylococcus aureus (MRSA) carriers or have a penicillin allergy. [35]

Antibiotics and their mechanisms of action: [31]

Antibiotic Name	Antibiotic Type	Mechanism of Action
Amoxicillin	Penicillin	Inhibits bacterial cell wall synthesis by targeting peptidoglycan.
Ciprofloxacin	Fluoroquinolone	Inhibits DNA gyrase, preventing DNA replication and transcription.
Doxycycline	Tetracycline	Interferes with protein synthesis by binding to the 30S ribosomal subunit.
Vancomycin	Glycopeptide	Inhibits cell wall synthesis in Gram-positive bacteria by binding to the peptidoglycan precursor.
Azithromycin	Macrolide	Blocks protein synthesis by binding to the 50S ribosomal subunit.
Trimethoprim-sulfamethoxazole	Sulfonamide	Inhibits folic acid synthesis in bacteria by targeting dihydrofolate reductase.
Gentamicin	Aminoglycoside	Disrupts protein synthesis by binding to the 30S ribosomal subunit.
Linezolid	Oxazolidinone	Inhibits bacterial protein synthesis by binding to the 50S ribosomal subunit.

Summary of recommendations and key actions for patients to participate in SSI prevention program [29]

Recommendations	Key actions for patients
1. *Staphylococcus aureus* screening and decolonization	For high risk surgery, nasal screening for methicillin-sensitive *S. aureus* (MSSA) or methicillin-resistant *S. aureus* (MRSA) carriage is recommended
	Decolonization treatment with mupirocin 2% ointment with or without a combination of chlorhexidine gluconate body wash prior to surgery is needed for nasal carriage of MSSA or MRSA
	Apply decolonization treatment at least the night and the morning before your surgery Decolonization treatment for 3–5 days before the surgery if possible
2. Smoking	Inform your doctor about your smoking history before surgery
	Quit smoking 4 weeks or longer before your surgery
3. Hair removal	Shaving is strongly discouraged
	Do not remove hair at the site of the planned incision when at home Hair should only be removed with an electrical clipper
4. Hand hygiene	Clean your hands before eating a meal; after visiting the toilet or using commode/urinal; before and after touching your drip (IV line) or drainage bag/tube
	Visitors should not touch your wound or dressings
	Speak up if you do not see HCWs clean their hands
5. Body temperature	Ask about the procedures followed to keep you warm throughout surgery
	Take a hot shower shortly before the surgery
	Avoid "cooling down"
	Ask for extra blankets to keep yourself warm during transportation
	Speak up, if you feel cold before or after surgery and ask for a blanket
6. Preoperative showering and bathing	Make sure your skin is clean before surgery
	Shower or bathe (full body) with either soap (antimicrobial or non-antimicrobial) on the night before and/or in the morning of the surgery
7. Diabetes mellitus	See your doctor at least one month before your scheduled surgery
	Maintain stable blood glucose levels before, during and after surgery
	Inform HCWs about your routine insulin regime
8. Wound care after surgery	The wound dressing should be kept in place for 48 h after surgery
	If change of dressing is necessary, this should be done under a clean technique
	Ensure that HCWs clean hands immediately before changing your dressing
	Visitors should not touch your wound or the dressing when visiting you
	Make sure you know and understand how to care for your wound before leaving the hospital
	Report any redness, pain, swelling or fever to HCWs
9. Multidrug-resistant organism risk (MDRO)	Inform HCWs about any travel history or previous recent hospitalisation
	Inform of any known carriage of any MDRO such as MRSA, Extended Spectrum β-Lactamase (ESBL) producing or Carbapenem-resistant Enterobacteriaceae (CRE)

3. INTRAOPERATIVE[10]

I. Use of Antibiotics

The timing and length of antibiotic administration during surgery are crucial in preventing infections. Although the initial preoperative dose is important, it is essential to consider that some surgeries may last longer than the duration of the antibiotic's effectiveness. In such cases, administering an additional dose during the procedure is recommended, especially for surgeries lasting more than 2-4 hours. This practice, known as intraoperative dosing, involves providing a supplementary dose of prophylactic antibiotics to maintain adequate antibiotic levels in the body as concentrations decrease over time. By ensuring that therapeutic levels are sustained throughout the surgery, intraoperative dosing offers ongoing protection against bacterial contamination and helps reduce the likelihood of surgical site infections (SSIs). [36]

In certain situations, local antibiotic administration during surgery is also utilized. This method involves applying antibiotics directly to the surgical site or the area at higher risk of infection. The local delivery of antibiotics offers an extra layer of protection, targeting the specific area of concern for more effective prevention. This approach is especially beneficial when the risk of infection is elevated due to the type of surgery being performed or the patient's particular condition. It works alongside systemic antibiotic treatments, contributing to a more thorough infection control strategy in the operating room. [37]

The surgical technique can substantially impact antibiotic efficacy. Adequate tissue perfusion, proper wound closure, and meticulous aseptic practices are essential to maximizing antibiotic prophylaxis's effectiveness. Ensuring that the surgical environment is as free from contamination as possible and that wounds are well-approximated help prevent bacterial entry and subsequent infection. [38]

II. Optimized Fluid Management

Fluid management strategies in Enhanced Recovery After Surgery (ERAS) protocols have transitioned from traditional restrictive or liberal approaches to a more refined method known as goal-directed therapy. This strategy utilizes real-time intraoperative monitoring to optimize fluid administration, ensuring hemodynamic stability and

reducing postoperative complications. By individualizing fluid management based on the patient's specific physiological needs, goal-directed therapy aims to improve surgical outcomes and minimize adverse events. [39]

The primary objective of intraoperative fluid management is to preserve end-organ perfusion by maintaining an adequate circulating volume. Hypovolemia increases the risk of organ hypoperfusion, potentially leading to sepsis and multiorgan failure. Conversely, hypervolemia can be equally detrimental, contributing to peripheral and pulmonary edema and elevating the likelihood of postoperative ileus. [40]

Several approaches to fluid management have been utilized to ensure optimal intraoperative hemodynamic stability. Historically, extensive abdominal surgeries have been linked to considerable fluid deficits resulting from preoperative fasting, bowel preparation, and intraoperative losses, including bleeding and third-spacing. To counteract these deficits, fluid administration during surgery has traditionally ranged between 10 to 15 mL/kg. [41]

Within the context of ERAS pathways, there are currently two fluid management strategies under debate: GDFT and individualized zero-balance or "restrictive" fluid regimens. [42]

- Goal-Directed Fluid Therapy:

  Goal-directed fluid therapy is based on optimization of preload to achieve a certain goal in stroke volume, cardiac index, or oxygen delivery. [41] A systematic review of major abdominal surgery found that utilizing transoesophageal Doppler was linked to a reduction in complications, a lower rate of intensive care unit admissions, and a quicker recovery of normal gastrointestinal function. [43]

- Zero-Balance or "Restrictive" Fluid Regimen:

  A zero-balance fluid regimen, commonly referred to as a "restrictive" fluid strategy, focuses on preventing postoperative weight gain by preserving intravascular normovolemia. This approach involves replacing only the fluids that are directly measured as lost, without compensating for third-space losses. Additionally, hemodynamic stability is maintained through the use of vasopressors rather than excessive fluid administration. [44]

Fluid Type

Numerous studies examining goal-directed fluid therapy (GDFT) within Enhanced Recovery After Surgery (ERAS) protocols have utilized hydroxyethyl starch (HES) as the preferred bolus fluid. However, research has shown that HES products may elevate the risk of acute kidney injury and the need for renal replacement therapy in critically ill patients. [41,45]

Continued debate exists surrounding the appropriate fluid type in GDFT and ERAS protocols. Due to their ability to increase intravascular volume more reliably and for a longer period of time than crystalloids, colloids have earned a place in many ERAS pathways. [41]

Patient care within these protocols should focus on maintaining a euvolemic state. Preoperatively, this includes reducing fasting duration for clear liquids to just two hours before anaesthesia initiation, along with the intake of a carbohydrate-rich beverage. Mechanical bowel preparation (MBP) using isosmotic solutions can be administered when appropriate, with careful monitoring of fluid balance. Intraoperative fluid management should follow a zero-balance approach, with selected patients receiving additional hemodynamic support through goal-directed fluid therapy. Postoperatively, patients should be encouraged to resume oral intake as soon as possible, while limiting the use of intravenous fluids. [46]

III. Maintaining Normothermia

Temperature is one of the five essential vital signs in humans, typically maintained within a narrow safe range of 36 to 37.5°C under normal conditions. This regulation is influenced by hormonal activity, heat production from cellular metabolism, and physical activity. [47,48]

Perioperative hypothermia frequently occurs due to the redistribution of heat from the core to the periphery, anaesthesia-induced disruptions in thermoregulation, and exposure to a cold surgical environment. [49]

Hypothermia is defined as core body temperature below 36 °C(2) and is further classified as mild (34°C-36 °C), moderate (32°C-34 °C), and severe (<32 °C). [48]

The most accurate sites for temperature monitoring include the pulmonary artery, distal oesophagus, nasopharynx, and tympanic membrane. [50]

Ensuring normothermia during surgery is essential not only for patient comfort but also for minimizing complications associated with hypothermia. These complications include a weakened immune response to surgical wound infections, protein depletion, impaired collagen synthesis, diminished platelet function, greater intraoperative blood loss, and an increased requirement for allogeneic blood transfusion.

Unintentional perioperative hypothermia, characterized by a core temperature dropping below 36°C during surgery, is a frequent occurrence in patients receiving general or regional anaesthesia when temperature regulation is not maintained. Within the first hour after anaesthesia induction, core body temperature can decrease by up to 1.6°C, heightening the risk of hypothermia, increased mortality, excessive intraoperative blood loss requiring transfusion, prolonged hospital stays, and surgical-site infections. [51]

In addition to contributing to increased blood loss, hypothermia can negatively impact blood coagulation, as indicated by prolonged activated partial thromboplastin time and bleeding time. [52]

Both active and passive warming systems are strongly recommended for preventing hypothermia. Effectively utilizing available resources through a structured protocol is essential, making this systematic review a valuable contribution to improving the management and prevention of perioperative hypothermia. The primary objective of maintaining a patient's body temperature during anaesthesia and surgery is to reduce heat loss by minimizing radiation and convection from the skin, evaporation from exposed surgical sites, and the cooling effects of administering cold intravenous fluids. [49]

Perioperative hypothermia can be managed using two key systems: [53]

1) Passive Warming Systems

   These methods reduce heat loss by providing external insulation, allowing the body's natural heat production to maintain temperature. Techniques include:

a. Increasing ambient temperature and using warm blankets.

b. Removing wet clothing and providing dry, insulated layers.

c. Protecting against wind and relocating to a warm environment.

d. Using heat and humidity exchangers and low-flow anaesthesia circuits.

2) Active Warming Systems

   These methods transfer heat directly to the patient and are effective for moderate to severe hypothermia. Techniques include:

a. Infrared lights, electric blankets, and warming mattresses.

b. Forced-air and convective air-warming systems.

c. Warming intravenous and irrigation fluids.

d. Humidifying anaesthetic gases and CO_2.

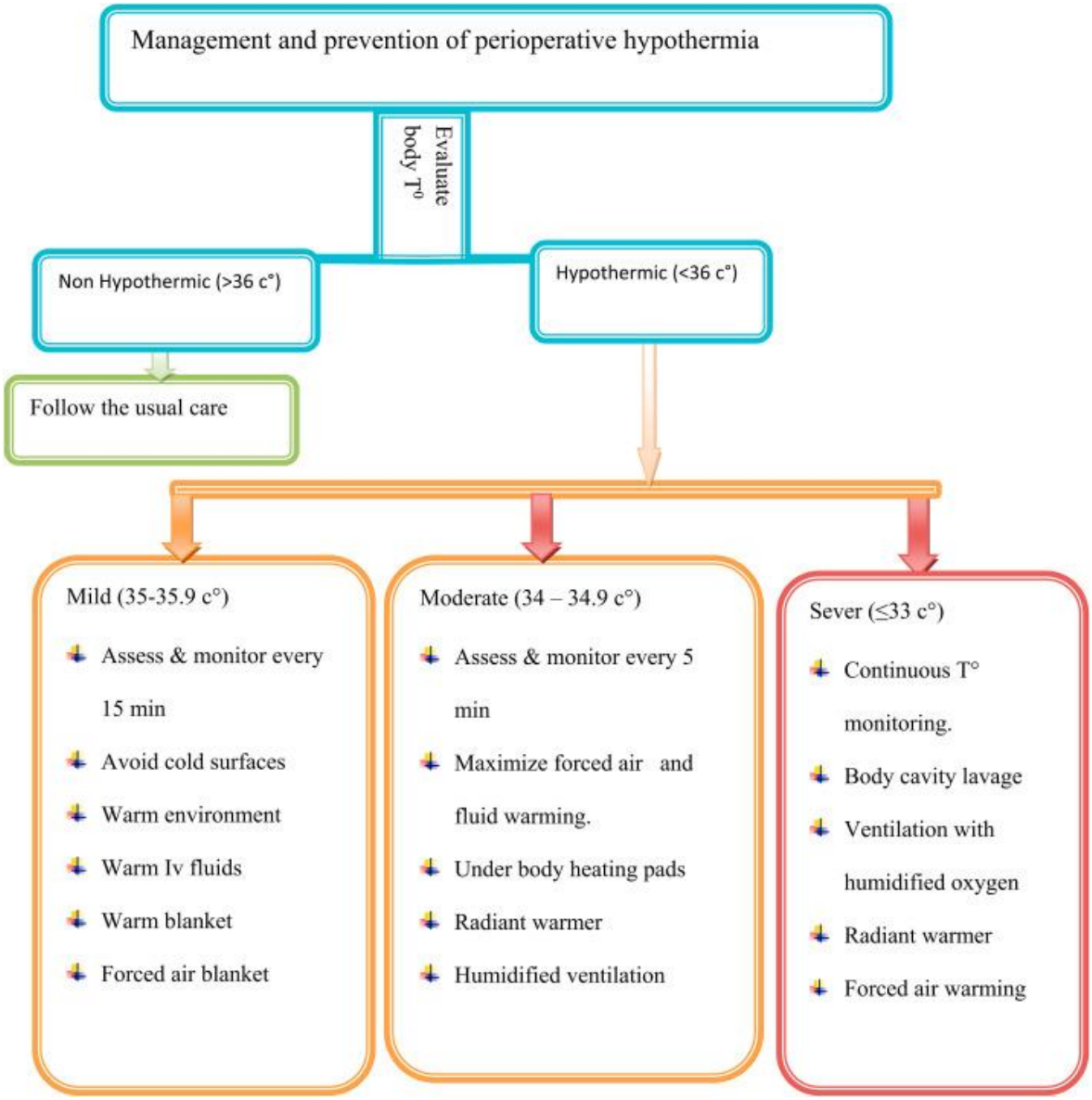
e. Using self-warming blankets that generate heat independently.

Both approaches are essential for maintaining normothermia and preventing complications during surgery.

Methods of warming systems, description and mechanism of heat transfer: [53,54]

Warming device	Description	Mechanism of Heat transfer
Warming blanket	Air delivered to variety of blankets at three settings: high (43°C), medium (38°C), low (32°C).	Convection
Circulating Water garment	circulates water from the control unit to polymer hyper/hypothermia blankets. Manual settings: 4–42°C; automatic: 30–39°C	Conduction
Heated air mattress	Ineffective, because limited body surface area comes into contact with the mattress.	Conduction
Hot packs	Temperature at approximately 54.5°C. Mean increase in temperature of 1.4°C.	Conduction
Humidified gases	Delivery of warm, humidified gas, which can increase the core temperature by 0.5–0.65°C/h.	Evaporation
Fluid warmer	Warmed fluids were found to increase the temperature by about 1.3°C.	Conduction
Forced Air Warming Systems	Forcing warmed air through the warming device to the container, which is in direct contact with the patient's skin (usually a two-layer blanket).	Convection

Management & Prevention of Perioperative Hypothermia:



4. POSTOPERATIVE

I. Multimodal Analgesia

Postoperative pain is one of the main postoperative adverse outcomes causing distress to patients, prolonging stays in ambulatory care units, and increasing the incidence of unanticipated admissions after surgery. [55]

The goal of multimodal analgesia is to effectively manage postoperative pain by utilizing a combination of analgesic agents. This approach integrates opioids and regional nerve blocks to modulate pain signals within the central nervous system (CNS), while nonsteroidal anti-inflammatory drugs (NSAIDs) primarily act at the peripheral level to prevent the initiation of pain signals. [56]

Many studies have shown additive and/or synergistic effects between NSAIDs and opioids, with reductions in pain scores or postoperative analgesic requirements in humans. [55]

Opioids

Opioids are highly effective analgesics, particularly for managing moderate-to-severe postoperative pain. Their mechanism of action involves binding to opioid receptors in the central nervous system (CNS), thereby reducing pain perception. The potency of each opioid is directly linked to its receptor affinity. However, their use in high doses requires caution due to potential side effects, including nausea, vomiting, sedation, ileus, constipation, and respiratory depression. [57–61]

NSAIDs

Nonsteroidal anti-inflammatory drugs (NSAIDs) play a crucial role in postoperative pain management due to their opioid-sparing properties and anti-inflammatory benefits. They help alleviate hyperalgesia by lowering prostaglandin levels both centrally and peripherally, along with other mechanisms that modulate pain at multiple sites. [55]

NSAIDs work by inhibiting cyclooxygenase (COX) enzymes, which include COX-1 and COX-2. COX-1 is primarily responsible for maintaining physiological homeostasis, while COX-2 is induced in response to pain and inflammation. [62,63]

Prostaglandins generated from arachidonic acid metabolism via COX-1 play a vital role in preserving gastric mucosal integrity, supporting normal platelet aggregation, and maintaining kidney function. [62,63]

Extensive research has explored the optimal timing of NSAID administration, particularly in the context of pre-emptive analgesia. This approach proposes that administering analgesics before surgery can mitigate the central neural response to the "injury barrage" triggered by C-fiber primary afferents due to surgical incision and other intraoperative noxious stimuli. By reducing central sensitization, this strategy is believed to lower postoperative pain intensity and decrease the need for analgesics after surgery. [55]

Wound Infiltration or Regional Block

Over the past decade, there has been a notable shift toward regional analgesia as a key approach in postoperative pain management. Techniques such as single-dose wound infiltration with local anaesthetics (WI) and continuous local anaesthetic infusion via catheters placed in the surgical wound (continuous wound infiltration, CWI) have been reintroduced as essential components of multimodal analgesia for managing postoperative pain following various surgical procedures performed under general or regional anaesthesia.[64]

While a pre-incisional block is ideal, wound infiltration (WI) is typically performed at the end of surgery in clinical practice. When used continuously, WI can decrease the need for additional analgesics, extend the duration of pain relief, and, in some cases, improve patient mobility. Its effectiveness has been demonstrated in procedures such as open abdominal surgeries (Caesarean section, colorectal surgery, abdominal hysterectomy, herniorrhaphy), laparoscopic cholecystectomy, oncologic breast surgeries, laminectomy, and radical prostatectomy. Given that local anaesthetic systemic toxicity occurs in approximately 11% of cases following subcutaneous wound infiltration (WI), ensuring proper dosing of local anaesthetics is essential for patient safety. [65]

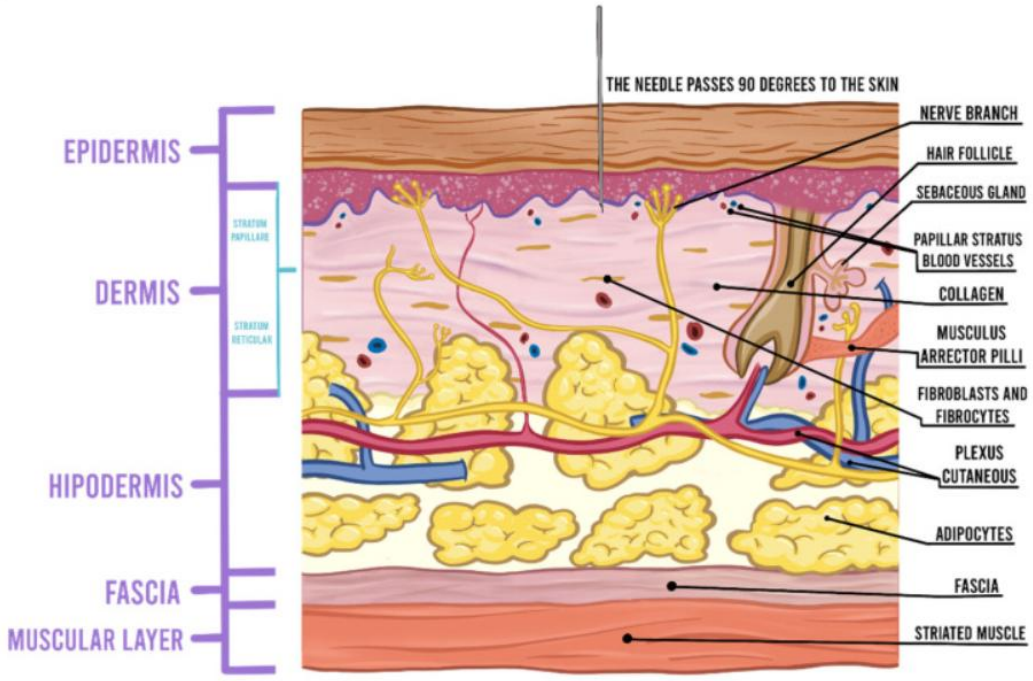
While continuous wound infiltration (CWI) offers multiple advantages, such as enhanced pain relief, decreased opioid consumption and associated side effects, higher patient satisfaction, and a shorter hospital stay, its use remains limited due to concerns about catheter displacement, infection risk, cost, and potential errors in technique. [66]

The term "local infiltration analgesia" (LIA) refers to the administration of a large volume of diluted, long-acting local anaesthetic into tissue structures, commonly used in knee and hip surgeries, to achieve effective pain relief. [65]

Technique for injection :

Using smaller diameter needles (27- to 30-gauge) slows the injection rate, thereby minimizing discomfort during administration. Intradermal injection of local anaesthetics induces anaesthesia more rapidly than subcutaneous injection. However, intradermal injections tend to cause more pain due to the stretching of densely innervated dermal tissue, whereas subcutaneous injections stretch the looser subcutaneous tissue. To reduce pain during intradermal injection, the needle should be inserted at a 90-degree angle, as this minimizes the number of pain fibers encountered. Pain can also be reduced by injecting just below the dermis into the subcutaneous fat at the level of the nerve trunk. Signs of successful intradermal injection include immediate whitening, skin tightening, or a "peau d'orange" appearance. [67]

Surgical site infiltration is ideally performed with a short 22-gauge needle with direct visualization of tissue layers. [68]



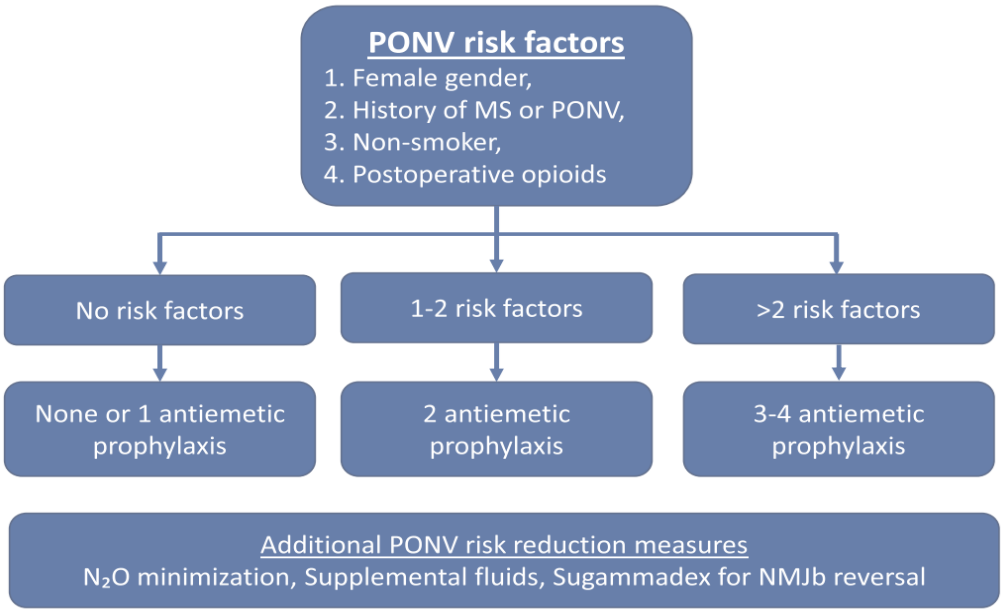
Complications after WI are rare, but can include local anaesthetic toxicity, wound infection, hematoma, and bruising. [69,70]

II. PONV Prophylaxis

Postoperative nausea and vomiting (PONV) remains one of the most common adverse events after surgery. It is distressing for patients, increases the risk of other adverse events such as readmission, and has a financial impact for the healthcare institution. [71] Management of PONV involves a framework of risk assessment, multimodal risk reduction, and prophylactic measures, as well as prompt rescue treatment. [72]

Patient-related factors—such as being female, a non-smoker, or having a prior history of motion sickness or postoperative nausea and vomiting (PONV)—can be evaluated using standardized tools like the **Apfel score** or the **Koivuranta score**. Additionally, certain surgical procedures, including cholecystectomy and open abdominal surgeries like laparotomy, are associated with an increased risk of PONV. Other perioperative contributors include prolonged surgical duration, the use of volatile anaesthetic agents (particularly nitrous oxide), and the administration of opioids during or after surgery. [73–76]

Aggressive PONV prevention strategy should be included in an ERAS protocol. All patients with 1–2 risk factors should receive as PONV prophylaxis a combination of two antiemetics. Patients with 3–4 risk factors should receive 2–3 antiemetics and total intravenous anaesthesia (TIVA) with propofol and opioid-sparing strategies should be encouraged. [77]



Risk factors & management of postoperative nausea and vomiting (PONV) [72]

Abbreviations: MS, motion sickness; NMJb, neuromuscular junction blocker; N2O, nitrous oxide.

The multimodal approach to PONV within an ERAS programme contains the use of antiemetics and a total intravenous anaesthesia (TIVA) with propofol instead of inhalational agents. Avoidance of nitrous oxide is also important. Several other potentially modifiable perioperative risk factors are discussed below. [78]

1. Propofol

Propofol is an intravenous general anaesthesia agent. Clinical trials and meta-analyses have shown that intravenous anaesthesia (TIVA) with propofol is associated with significantly lower risk of PONV than volatile anaesthesia. Advantages for propofol over volatiles could be demonstrated throughout subgroups for PONV. Evidence for lower pain scores could be seen for propofol use in the overall analysis, and in the subgroups of laparoscopic and in-patient surgical procedures. [79]

2. Nitrous Oxide Sparing Anaesthesia

Nitrous oxide is a gaseous anaesthetic agent with mild analgesic effect, however, it increase the risk of early postoperative nausea and vomiting, particularly in patients who have not had prophylactic anti-emetic therapy. Nitrous oxide should be avoided in those at high-risk of postoperative nausea and vomiting. [80,81]

3. Lidocaine Infusion

Studies have demonstrated that intravenous lidocaine is an effective analgesic in several major abdominal procedures. It has been proposed that the opioid sparing effect of lidocaine infusion may also result in a lower incidence of PONV. [82]

Kaba et al [83] demonstrated in his study that perioperative intravenous infusion of nontoxic doses of lidocaine improved postoperative analgesia, reduced postoperative opioid requirements, accelerated postoperative recovery of bowel function, attenuated postoperative fatigue, reduced the duration of hospitalization, and facilitated acute rehabilitation in patients undergoing laparoscopic abdominal surgery.

4. Dexmedetomidine

Dexmedetomidine is a highly selective α-2 adrenergic agonist with sedative and analgesic properties. It can be administered intravenously or as a regional anaesthesia adjunct. When administered intravenously, dexmedetomidine is thought to reduce postoperative pain and opioid requirement. [84]

Shenhui et al [85] reported in one of his meta-analysis dexmedetomidine administrated in continuous infusion mode has the advantage to prevent PONV as well as reduce side effects such as bradycardia and hypotension.

5. Supplemental Fluids

It has been suggested that perioperative fluid status is an important risk factor for the development of PONV. The role of preoperative carbohydrate solution is currently unclear. [84]

Intraoperative fluid administration may affect the risk of PONV. **James et al** [86] found that 10–30 mL/kg intraoperative crystalloids infusion significantly reduces the risk of both early and late PONV and the need for rescue antiemetics.

Colloid solutions (such as hydroxyethyl starch) contain macromolecules which are thought to remain in the intravascular component for a longer period of time, compared to fluid supplementation with crystalloids, colloids significantly reduced the risk of PONV in longer surgeries (>3 hours) when compared to shorter surgeries (<3 hours). [84]

6. Opioid Free Anaesthesia/Analgesia

Avoidance of opioids in the perioperative period eliminates the risk of any opioid related adverse events, this includes PONV, as well as respiratory depression and ileus. [87]

Novel Rescue Treatment

In patients with established PONV (with or without prior PONV prophylaxis), common rescue treatment includes ondansetron, promethazine, and droperidol. [84]

IV amisulpride at 5 and 10 mg is also safe and efficacious in the treatment of established PONV in surgical patients undergoing general anaesthesia with no prior PONV prophylaxis. [88]

III. Avoidance of Nasogastric Suction & Intraabdominal Drains

Enhanced recovery after surgery (ERAS) programs should aim to achieve the highest level of compliance with all items in the guidelines. One of the primary recommendations is to avoid the routine use of nasogastric tubes and/or abdominal drains. Existing research indicates that the routine use of nasogastric tubes for decompression does not contribute to earlier return of bowel function, reduced hospital stay, or lower rates of infection or anastomotic leakage. Noninsertion or early removal of tubes such as nasogastric tubes and urinary catheters have been readily accepted by clinicians as studies have shown a positive impact on early recovery. They can also be easily reinserted if a need arises in the postoperative period. Removal of urinary catheter after a short period of time postoperatively seems to be associated with lower rates of recatheterization, bladder infection, and length of stay. Likewise, routine placement of abdominal drains has not demonstrated any significant benefit in preventing complications such as nausea, vomiting, surgical site infections, abscesses, anastomotic breakdowns, or lymphocyst formation. In some cases, the use of drains has even been linked to detrimental effect on early mobilization, higher morbidity and delayed postoperative recovery. Therefore, ERAS protocols strongly advocate for minimizing or eliminating the routine use of nasogastric and abdominal drains to support quicker and safer recovery for surgical patients. [89,90]

Advantages of Early Drain Removal in ERAS Protocols [91–94]

S. No.	Advantage	Description
1.	Faster Mobilization	Drains can limit movement; early removal supports early ambulation.
2.	Reduced Risk of Infection	Shorter drain duration decreases the risk of surgical site and tract infections.
3.	Improved Patient Comfort	Minimizes pain, anxiety, and physical restriction caused by drains.
4.	Shorter Hospital Stay	Patients can be discharged earlier when drains are not in place.
5.	Fewer Drain-Related Complications	Reduces risk of blockage, leakage, irritation, and accidental dislodgement.
6.	Enhances ERAS Protocol Synergy	Complements other ERAS elements like early feeding and mobilization.
7.	No Proven Routine Benefit	Studies show no significant reduction in abscesses or leaks with routine use.

IV. Early Mobilization

Early mobilization is a crucial component of enhanced recovery after surgery (ERAS) pathways that counteract the adverse physiological consequences of surgical stress and immobilization. Early mobilization reduces the risk of postoperative complications, accelerates the recovery of functional walking capacity, positively impacts several patient-reported outcomes and reduces hospital length of stay, thereby reducing care costs.[95]

Hospitalization can result in a rapid decline in function, especially in older adults. [96] Prolonged immobilization contributes to heightened insulin resistance, disrupts normal

gastrointestinal activity, leads to cardiovascular, respiratory, and musculoskeletal deconditioning, and elevates the risk of developing thromboembolic events. [97,98]

Challenges associated with early postoperative mobilization: [99]

1. Postoperative complications, delirium, and reoperations can delay early mobilization.
2. Advanced age, poor physical fitness, and malnutrition are associated with slower recovery and reduced mobility.
3. The use of catheters, drains, and inadequate pain management limits patient movement.
4. Opioid-sparing analgesia and minimally invasive surgical techniques help facilitate earlier mobilization.
5. Lack of awareness and institutional culture that does not emphasize early ambulation contribute to low compliance.
6. Limited availability of physiotherapists and support staff restricts effective implementation of mobilization protocols.
7. Psychological factors such as pain, fatigue, fear of falling, and outdated beliefs about bed rest hinder patient motivation.
8. Absence of clear postoperative instructions can result in delays in initiating mobilization.
9. Nurses play a crucial role but require adequate time, training, and institutional support to assist patients.

Integration of structured exercise and mobility into perioperative care

Once patients achieve meaningful mobilization (within 24 h after surgery, if possible), structured and progressive movement that helps patients accelerate toward independent mobilization is also crucial. Including resistance exercise to regain lost muscle mass or strength, and improve overall function, may make the transition to recovery at home easier. [99]

Recent advances include improving the measurement of mobilization quantity and providing real-time feedback to patients via wearable technology, adding exercise

across the perioperative period (including exercise prehabilitation) and using animated visualization to improve recovery. [99]

Steps of Early Mobilization in ERAS Protocols [100]

Timely removal of catheters, intravenous lines, and surgical drains to facilitate unrestricted mobility and reduce infection risk.
Progressive ambulation with supervision during POD 1–3, increasing the frequency and distance based on patient tolerance.
Optimized analgesia with opioid-sparing strategies to provide effective pain control while minimizing sedation and gastrointestinal side effects.
Preoperative education and patient engagement to enhance understanding, set expectations, and encourage active participation in recovery.
Supported standing and short-distance ambulation on POD 0–1 to enhance circulation, respiratory function, and musculoskeletal strength.
Initiation of physiotherapy within the first 24 hours postoperatively to promote early functional recovery and reduce complications.
Assisted sitting at the bedside on postoperative day 0 (POD 0) to begin reconditioning and prevent deconditioning associated with prolonged bed rest.

V. Early Feeding

Nutritional support plays a pivotal role during the inflammatory and metabolic phases of postoperative recovery, contributing significantly to improved clinical outcomes. Among the available modalities, enteral nutrition (EN) has been consistently associated with reduced postoperative complications and shortened hospital stays, particularly in patients undergoing elective gastrointestinal (GI) surgeries. Beyond elective settings, EN has demonstrated substantial clinical benefits in surgical patients, including the reduction of infectious complications, prevention of bacterial translocation and aspiration, and mitigation of multiple organ dysfunction syndrome. Recent evidence also supports the feasibility and therapeutic value of early enteral nutrition (EEN) following emergency GI surgeries. When appropriately implemented, EEN can enhance recovery without increasing complications. However, careful patient selection remains essential, as contraindications such as intestinal obstruction, malabsorption, high-output fistulas, intestinal ischemia, severe hemodynamic instability with compromised splanchnic perfusion, or fulminant sepsis may preclude its safe use. [101]

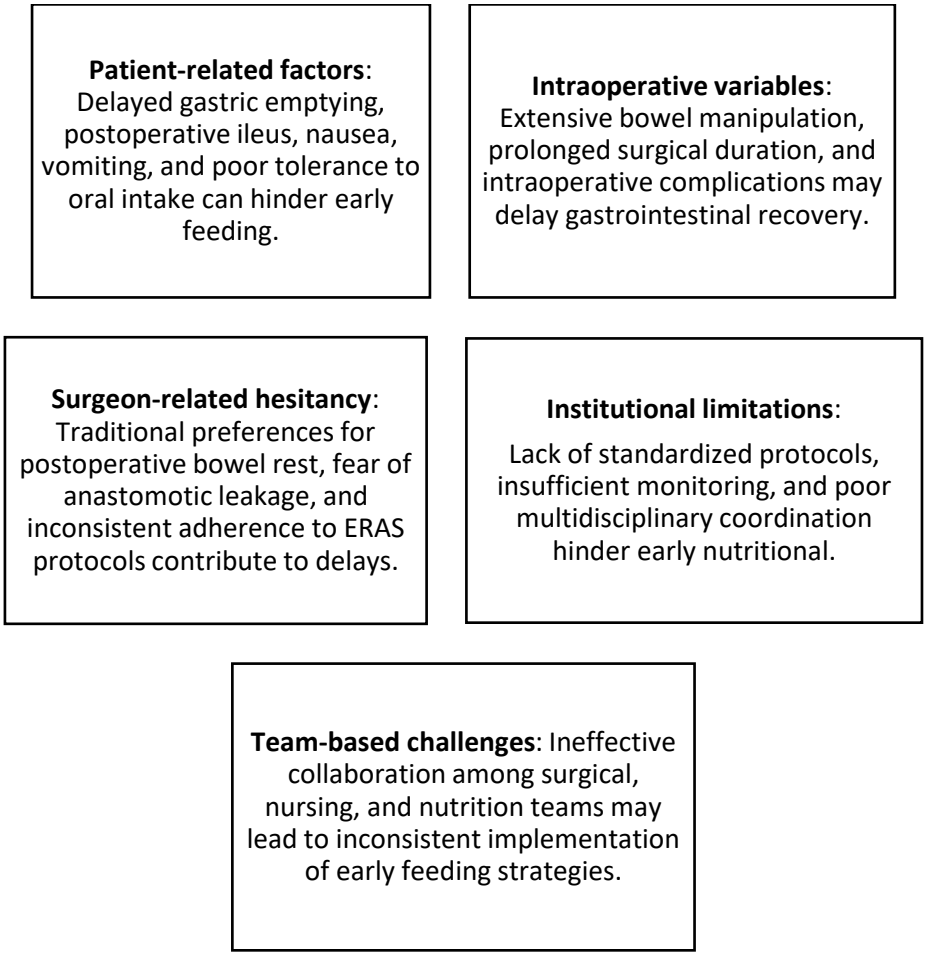
Traditional postoperative care (TPC) following abdominal surgery typically involves the selective placement of a nasogastric tube (NGT) and maintaining patients in a "nil by mouth" state until there is clear evidence of restored gastrointestinal function. Nutritional intake is gradually reintroduced, beginning with clear liquids and subsequently advancing to a solid diet. This approach is based on the rationale that gastrointestinal rest minimizes the risk of postoperative nausea, vomiting, and abdominal distention, while also safeguarding the integrity of intestinal anastomoses. [102,103]

There is strong evidence from elective surgery studies, including colorectal and upper gastrointestinal surgery that TPC brings no benefits, and outcomes are even worse when compared to early feeding. [104]

Although preoperative nutritional optimization is often not feasible in cases of emergency laparotomy (EL), postoperative dietary management should adhere to ERAS principles and be individualized based on the patient’s underlying pathology.

Emerging evidence suggests that early feeding may offer benefits even in emergency surgical settings. [105]

Klappenbach et al [106] in a randomized controlled trial demonstrated that initiating feeding within 24 hours of surgery did not increase the risk of complications, postoperative ileus, or prolong length of stay when compared to the traditional approach of delaying feeding until after the passage of flatus or stool. While early feeding was associated with a higher incidence of vomiting, it was easily managed and did not result in patient discomfort. Additionally, **Lee et al** [101] conducted a retrospective propensity-matched study indicated that patients who received early postoperative feeding had lower rates of mortality and complications.


Patient-related factors: Delayed gastric emptying, postoperative ileus, nausea, vomiting, and poor tolerance to oral intake can hinder early feeding.
Intraoperative variables: Extensive bowel manipulation, prolonged surgical duration, and intraoperative complications may delay gastrointestinal recovery.
Surgeon-related hesitancy: Traditional preferences for postoperative bowel rest, fear of anastomotic leakage, and inconsistent adherence to ERAS protocols contribute to delays.
Institutional limitations: Lack of standardized protocols, insufficient monitoring, and poor multidisciplinary coordination hinder early nutritional.
Team-based challenges: Ineffective collaboration among surgical, nursing, and nutrition teams may lead to inconsistent implementation of early feeding strategies.

Barriers to Initiating Early Enteral Feeding Following Abdominal Surgery within the ERAS Protocol [107]

VI. Venous Thromboembolism (VTE) Prophylaxis

Major abdominopelvic surgery significantly increases the risk of postoperative venous thromboembolism (VTE), including both deep vein thrombosis (DVT) and pulmonary embolism (PE), contributing notably to postoperative morbidity and mortality. Given that postoperative hypercoagulability may persist for up to 30 days, current guidelines advocate the use of pharmacological thromboprophylaxis in patients without a high risk of bleeding. [108]

Enhanced Recovery After Surgery (ERAS) has emerged as a standard of care endorsed by various clinical guidelines and widely adopted in surgical practice. Several postoperative components of the ERAS protocol have been shown to reduce the risk of venous thromboembolism (VTE). Key measures such as early mobilization on the day of surgery, along with prompt removal of urinary catheters and intravenous lines, contribute to lowering the incidence of postoperative VTE. [109] The postoperative optimization of thromboprophylaxis—both mechanical and pharmacological, including appropriate dosing and timing—has been identified as a crucial component of the ERAS protocol, contributing significantly to improved patient outcomes and the prevention of venous thromboembolism. [110]

Mechanical VTE Prophylaxis Methods [110–112]

Method	**Mechanism of Action**	**Clinical Notes**
Intermittent Pneumatic Compression (IPC) Devices	Promote venous return through cyclic compression	Used intra- and postoperatively; requires patient compliance
Graduated Compression Stockings (GCS)	Apply graded pressure to lower limbs	Most effective when combined with pharmacological methods
Venous Foot Pumps	Stimulate venous flow via plantar compression	Common in orthopaedic and high-risk patients
Early Ambulation	Enhances calf muscle pump activity	A core ERAS component; reduces venous stasis

Pharmacological VTE Prophylaxis Agents [113–115]

Agent	**Class**	**Mechanism of Action**	**Common Uses**
Low Molecular Weight Heparin (e.g., Enoxaparin)	Anticoagulant (Heparin derivative)	Inhibits factor Xa and IIa	Standard for most surgical patients
Unfractionated Heparin	Anticoagulant	Inhibits thrombin and factor Xa	Preferred in renal impairment
Fondaparinux	Synthetic factor Xa inhibitor	Selectively inhibits factor Xa	Alternative in heparin-induced thrombocytopenia (HIT)
Direct Oral Anticoagulants (DOACs) (e.g., Rivaroxaban, Apixaban)	Oral Xa inhibitors	Inhibit activated factor Xa	Used in selected elective surgical settings

Barriers to implementation of extended duration thromboprophylaxis :

While extended-duration thromboprophylaxis offers a modest reduction in symptomatic VTE, several important considerations influence its clinical application. The high cost of low molecular weight heparin (LMWH) poses a financial challenge for both patients and healthcare systems, and its routine use in all patients undergoing cancer-related abdominopelvic surgery has not been shown to be cost-effective. Targeting high-risk patients may be a more economically viable strategy. Additionally, the need for daily subcutaneous injections can affect patient adherence, especially when compared to more convenient oral alternatives. These factors, along with limited implementation science and reliance on passive dissemination of evidence, have contributed to the underutilization of extended thromboprophylaxis. Focused

implementation strategies addressing these barriers could help translate evidence into clinical practice more effectively. [109]

In summary, Enhanced Recovery After Surgery (ERAS) is an evidence-based, multidisciplinary approach that optimizes perioperative care to reduce surgical stress and accelerate recovery. Established by the ERAS Study Group in 2001, it replaces traditional practices with standardized, patient-centered protocols. In gastrointestinal surgeries, ERAS has demonstrated reduced complications, shorter hospital stays, and improved outcomes without increasing readmission rates.

Key elements include preoperative carbohydrate loading, selective bowel preparation, prophylactic antibiotics, goal-directed fluid therapy, normothermia maintenance, and opioid-sparing multimodal analgesia. Postoperatively, ERAS emphasizes early mobilization, early enteral nutrition, and minimization of routine nasogastric tubes and drains. Current literature supports ERAS as a safe and effective strategy that improves recovery and patient satisfaction across a broad surgical population.

Aarts et al [116] conducted a study on adoption of enhanced recovery after surgery (ERAS) strategies for colorectal surgery at academic teaching hospitals and impact on total length of hospital stay. A multiregression analysis was performed to assess for factors independently associated with a total length of hospital stay of 5 days or less. It was concluded that in hospitals with variable uptake of ERAS strategies, preoperative counselling, intraoperative fluid restriction, use of a laparoscopic approach, immediate initiation of clear fluids after surgery, and early discontinuation of the Foley catheter are all independently associated with shortened length of stay.

Ljungqvist et al [117] A study was conducted to evaluate the impact of Enhanced Recovery After Surgery (ERAS) protocols on surgical outcomes and healthcare efficiency. The ERAS approach, involving a multidisciplinary team and evidence-based perioperative care strategies—such as preoperative carbohydrate drinks, minimally invasive surgery, optimized fluid management, early mobilization, and prompt nutrition—was implemented across various surgical specialties. The study observed significant reductions in hospital stay (by 30–50%), postoperative complications, readmissions, and overall treatment costs. The study concluded that ERAS is a highly

effective, value-based care model that improves clinical outcomes and enhances cost-efficiency in surgical practice.

Yeon et al [118] conducted a comprehensive study to evaluate the application and efficacy of Enhanced Recovery After Bariatric Surgery (ERABS) protocols, encompassing pre-, intra-, and postoperative care elements such as patient education, opioid-sparing analgesia, PONV prophylaxis, and goal-directed fluid therapy. This study reviewed multiple randomized controlled trials, systematic reviews, and meta-analyses involving thousands of patients undergoing procedures like sleeve gastrectomy and Roux-en-Y gastric bypass. The findings consistently demonstrated that ERABS protocols significantly reduced hospital length of stay, improved postoperative pain control, minimized PONV, and enhanced early recovery without increasing complications or readmission rates. The study concluded that ERABS is a safe and effective strategy for optimizing postoperative outcomes in bariatric surgery, though continued research and high-quality trials are needed to strengthen evidence and refine protocol standardization, especially in high-risk patient groups.

Azagury et al [119] conducted a randomized controlled study to evaluate the short- and long-term effects of preoperative oral carbohydrate loading (CHL) and immediate postoperative peripheral parenteral nutrition on outcomes in morbidly obese patients undergoing laparoscopic Roux-en-Y gastric bypass. A total of 203 patients were randomized into standard care and intervention groups, with primary outcomes focused on lean body mass (LBM) assessed via bioelectrical impedance analysis at one and twelve months postoperatively. Secondary outcomes included excess body weight loss (EBWL), 30-day complication rates, and hospital stay duration. The study found no significant differences between groups in terms of LBM preservation, EBWL, complications, or length of stay. The study concluded that while CHL and early postoperative parenteral nutrition are safe, they do not confer measurable benefits in LBM preservation or clinical outcomes in morbidly obese patients, including those with Type 2 diabetes.

MATERIALS AND METHODS

STUDY AREA- Department of General Surgery, Santosh medical college and hospital, Ghaziabad.

STUDY DESIGN- Randomized Controlled Trial

DURATION OF STUDY- 1.5 years

SAMPLE SIZE: [120]139 each group, total = 278

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	1000000
Hypothesized % frequency of outcome factor in the population (*p*):	90%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	139
80%	60
90%	98
97%	170
99%	239
99.9%	390
99.99%	545

Equation

Sample size $n = [DEFF*Np(1-p)]/ [(d^2/Z^2_{1-\alpha/2}*(N-1)+p*(1-p)]$

Results from OpenEpi, Version 3, open source calculator--SSPropor

$$n = deff \times \frac{N\hat{p}\hat{q}}{\frac{d^2}{1.96^2}(N-1) + \hat{p}\hat{q}}$$

where

n = sample size
$deff$ = design effect
N = population size
$\hat{p}$ = the estimated proportion
$\hat{q} = 1 - \hat{p}$
d = desired absolute precision or absolute level of precision

References

Schaeffer RL, Mendenhall W, Ott L. Elementary Survey Sampling, Fourth Edition. Duxbury Press, Belmont, California 1990.

Inclusion criteria

1) Age 18-80 years

2) Both male & female patients

3) Elective cases

Exclusion patients

1) Patients less than 18 years and more than 80 years of age

2) Immunocompromised patients (without optimization)

3) Emergency cases

Methodology -After taking the required consent, patients will be randomly divided into 2 groups as ERAS group and conventional recovery group using Clinical Trial Randomization Tool, National Cancer Institute. Patients will be assessed under the following-

1. Day of mobilization
2. Toleration of feed
3. Status of wound
   Healthy wound healing present or not
   Surgical site infection (SSI)
   Appearance of scar
4. Relevant investigation findings
5. Quality of life
   Improved
   Not improved

RANDOMIZATION PROCESS-

Randomization done was done_using the Clinical Trial Randomization tool was developed by the NCI Division of Cancer Prevention and may be found at:https:// ctrandomization.cancer.gov/

DATA ANALYSIS PLAN

The data will be collected and entered in MS excel 2010. Different statistical analysis will be performed using Stata MP-17. The one-sample Kolmogorov – Smirnov test will be employed to determine whether the data sets differed from a normal distribution or not. Normally distributed data will be analysed using parametric tests and non - normally distributed data will be analysed using non parametric tests. Descriptive statistics will be calculated for qualitative and categorical variables. Graphical representation of the variable will be shown to understand the results clearly and to measure the association for categorical dataset will be analysed using Chi-Square test. Independent T-test or student t-test will be applied to measure the mean difference between two groups. Correlation will be estimated to measure the strength of relationship between two or more quantitative variables. If p value <0.05, considered as statistically significant and if p-value>0.05, then it is statistically insignificant.

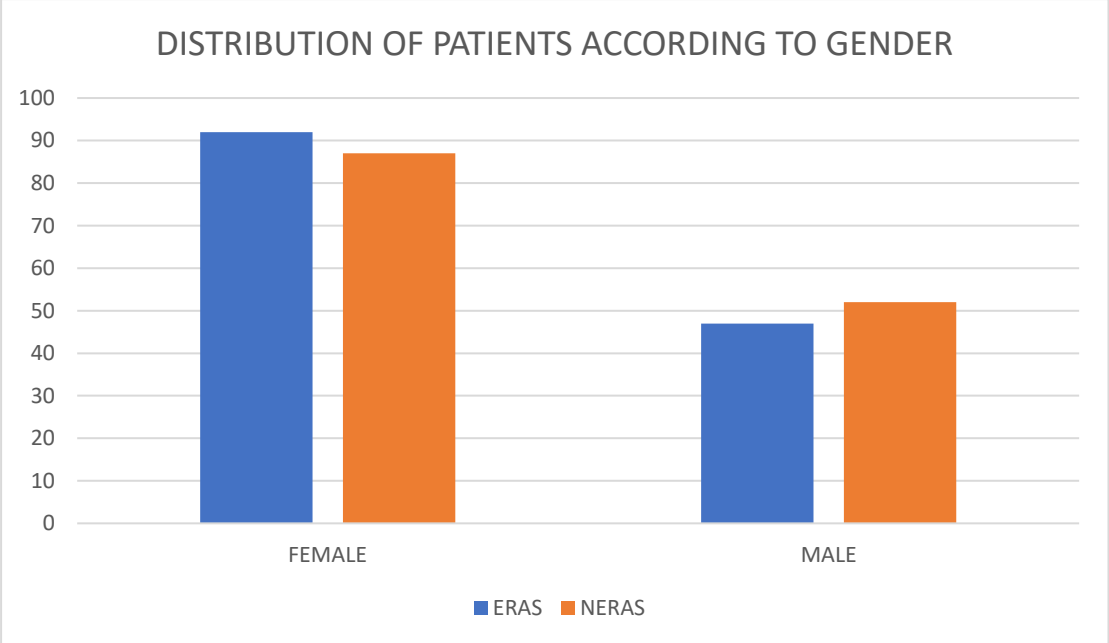
OBSERVATIONS & RESULTS

TABLE 1: DISTRIBUTION OF PATIENTS ACCORDING TO GENDER

SEX	ERAS	NERAS
F	92	87
M	47	52
GRAND TOTAL	**139**	**139**

p-value: 0.531

Table 1 shows the distribution of patients by gender between the ERAS and non-ERAS groups showed no statistically significant difference (p-value = 0.531). In the ERAS group, 92 patients (approximately 66.2%) were female and 47 (33.8%) were male, while in the non-ERAS group, 87 (62.6%) were female and 52 (37.4%) were male.



GRAPH 1: DISTRIBUTION OF PATIENTS ACCORDING TO GENDER

TABLE 2: DISTRIBUTION OF CARBOHYDRATE LOADING IN BOTH GROUPS

Carbohydrate Loading	ERAS	NERAS
YES	139	0
NO	0	139
GRAND TOTAL	**139**	**139**

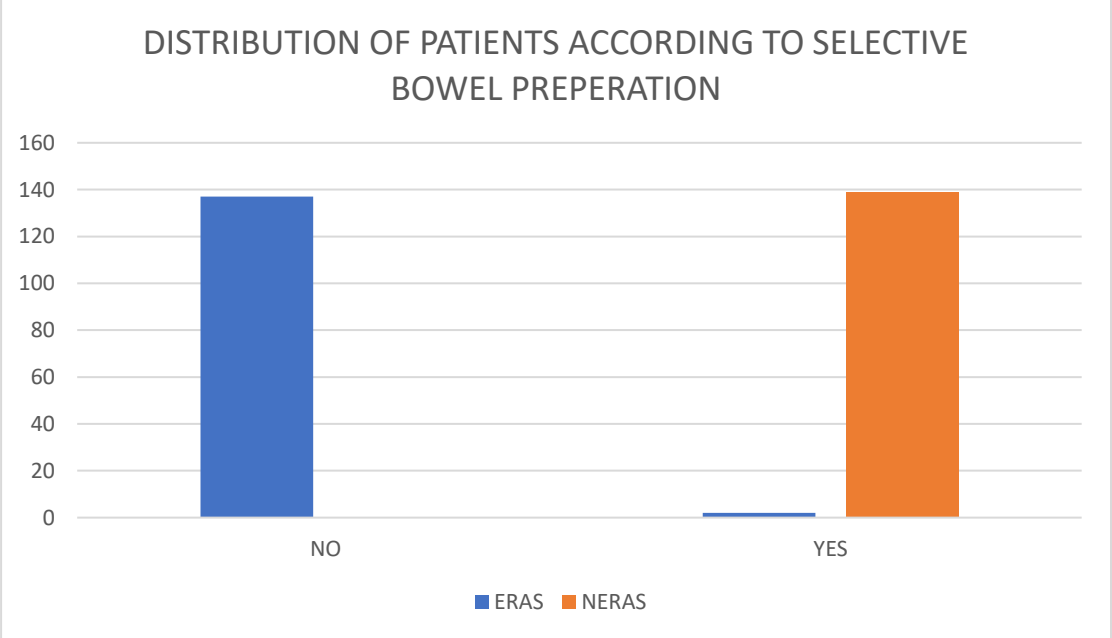
Table 2 shows a perfect association between Carbohydrate Loading and the type of protocol (ERAS vs. NERAS) 100% of patients in the ERAS group received carbohydrate loading and 0% in the NERAS group received it.

TABLE 3: DISTRIBUTION OF PATIENTS ACCORDING TO SELECTIVE BOWEL PREPERATION

SELECTIVE BOWEL PREPARATION	ERAS	NERAS
NO	137	0
YES	2	139
GRAND TOTAL	**139**	**139**

p-value = 7.70×10^{-60}

Table 3 shows that there was a highly significant difference in the use of selective bowel preparation between the two groups (p-value < 0.001). Almost all patients in the ERAS group (137 out of 139, 98.6%) did not receive bowel preparation, whereas the entire non-ERAS group (139 out of 139, 100%) underwent bowel preparation.



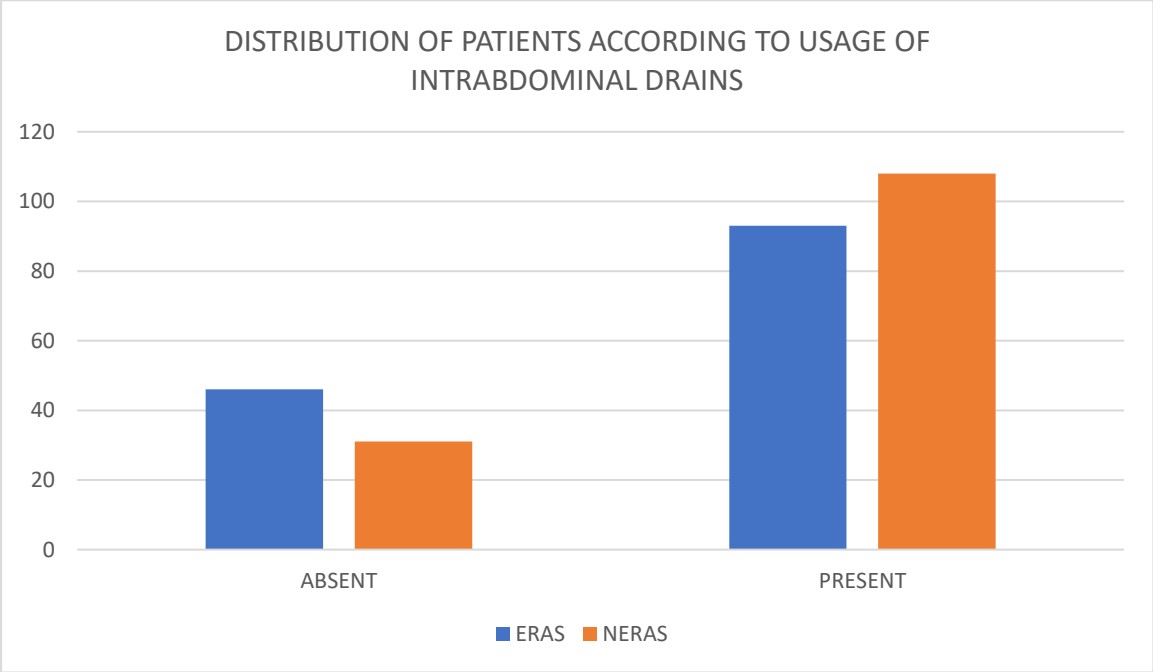
GRAPH 2: DISTRIBUTION OF PARTICIPANTS ACCORDING TO SELECTIVE BOWEL PREPERATION

TABLE 4: DISTRIBUTION OF PATIENTS ACCORDING TO USAGE OF INTRABDOMINAL DRAINS

DRAIN	ERAS	NERAS
ABSENT	46	31
PRESENT	93	108
GRAND TOTAL	**139**	**139**

p-value = 0.044

Table 4 shows that the use of surgical drains was significantly different between the two groups (p-value = 0.044). In the ERAS group, drains were absent in 46 patients (33.1%) and present in 93 patients (66.9%). In contrast, in the non-ERAS group, only 31 patients (22.3%) had no drain, while 108 patients (77.7%) had drains placed.



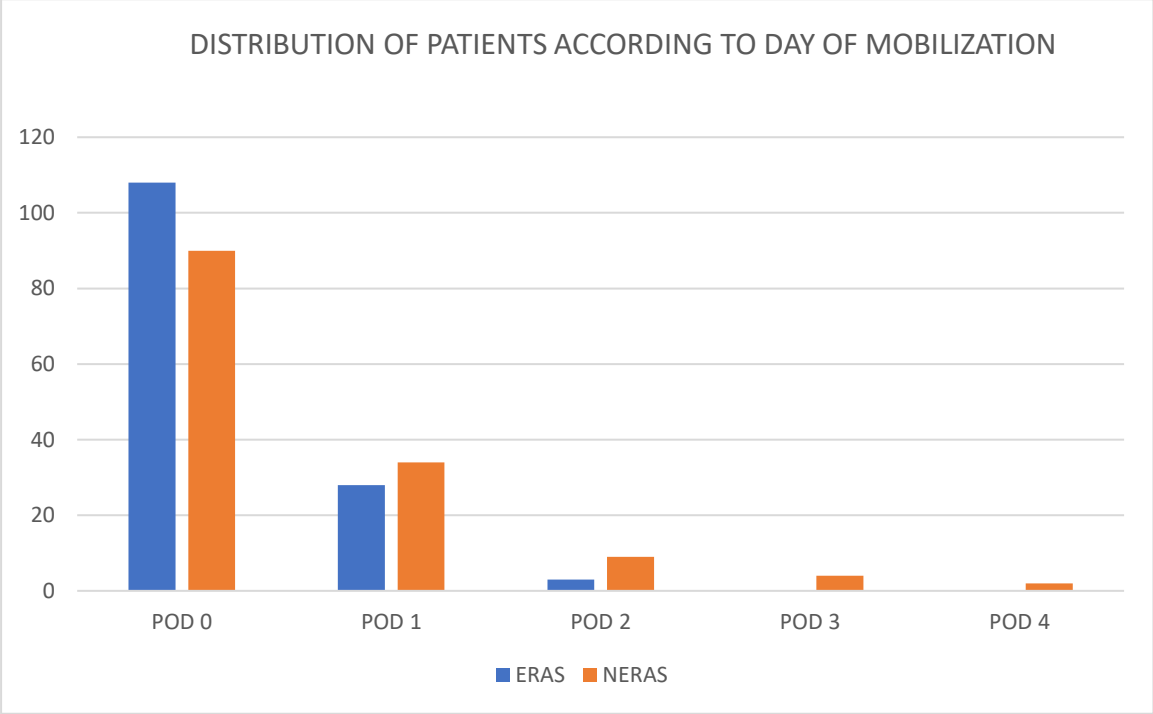
GRAPH 3: DISTRIBUTION OF PATIENTS ACCORDING TO USAGE OF INTRABDOMINAL DRAIN

TABLE 5: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF MOBILIZATION

Day of Mobilization	**ERAS**	**NERAS**
POD 0	108	90
POD 1	28	34
POD 2	3	9
POD 3	0	4
POD 4	0	2
Grand Total	139	139

p-value 0.0242

Table 5 shows that the p-value is 0.0242, which is less than 0.05, indicating a statistically significant difference in day of mobilization between ERAS and NERAS groups. This means that the differences in mobilization timing, especially earlier mobilization in the ERAS group are not due to chance.



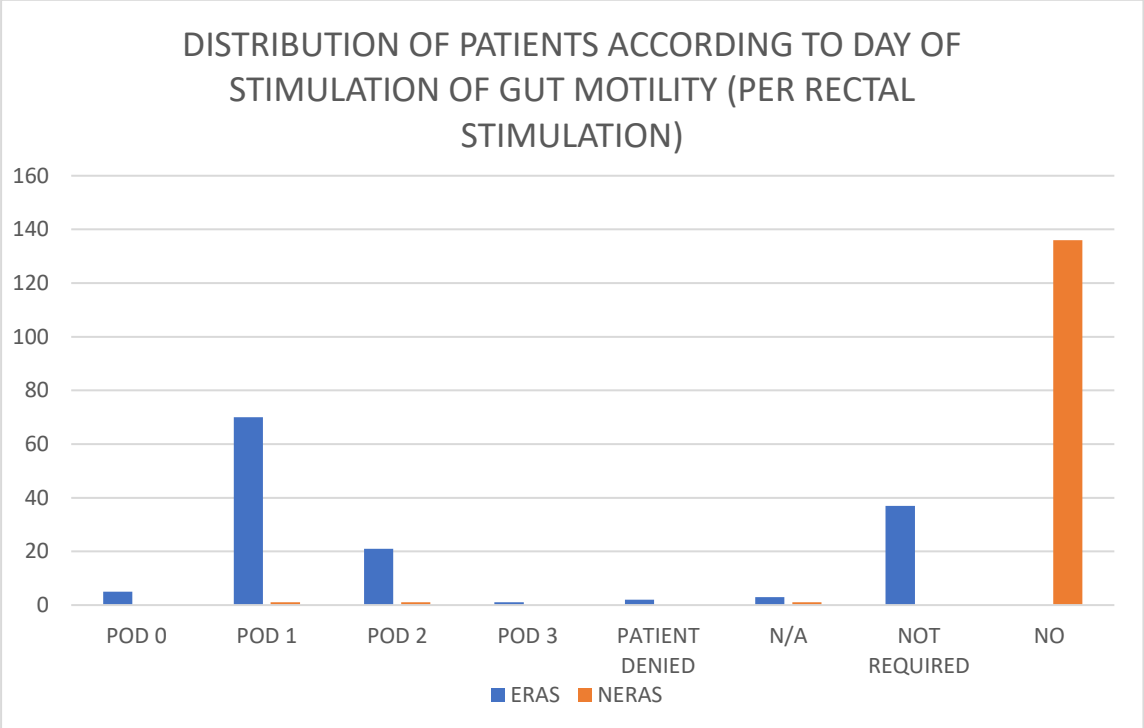
GRAPH 4: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF MOBILIZATION

TABLE 6: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF STIMULATION OF GUT MOTILITY (PER RECTAL STIMULATION)

Stimulation of Gut Motility	ERAS	NERAS
POD 0	5	0
POD 1	70	1
POD 2	21	1
POD 3	1	0
PATIENT DENIED	2	0
N/A	3	1
NOT REQUIRED	37	0
NO	0	136
GRAND TOTAL	139	139

p-value < 0.00001

Table 6 shows the distribution of patients receiving stimulation of gut motility via per rectal stimulation giving an extremely small p-value (< 0.00001) indicates a very strong and statistically significant association between the surgical protocol and the use of gut motility stimulation.



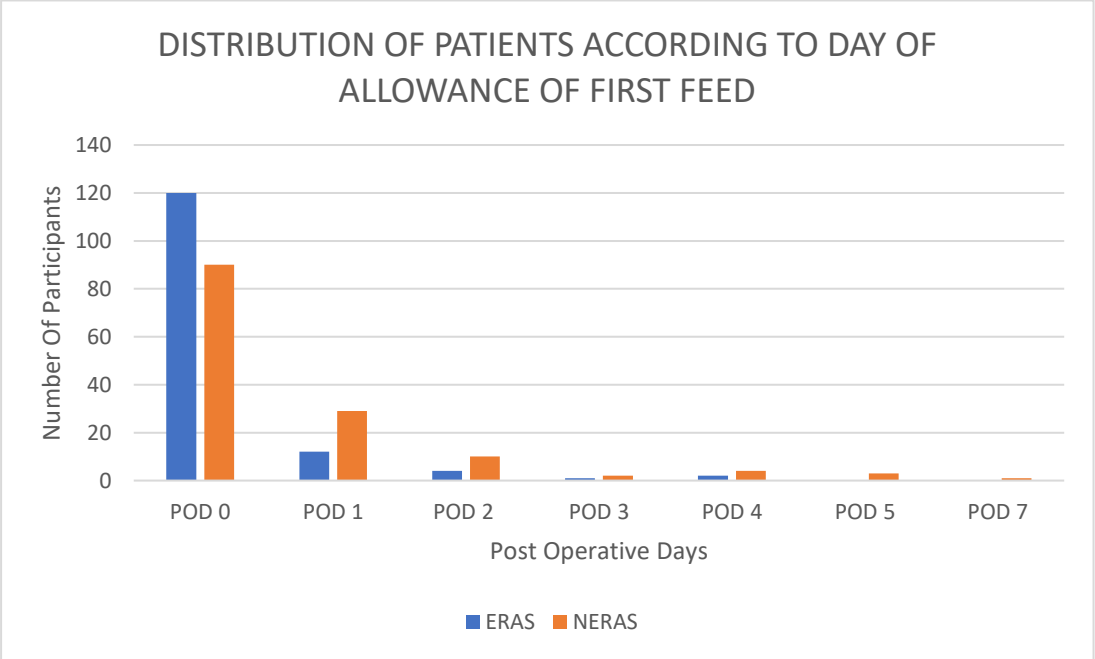
GRAPH 5: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF STIMULATION OF GUT MOTILITY (PER RECTAL STIMULATION)

TABLE 7: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF ALLOWANCE OF FIRST FEED

Feed Allowed	**ERAS**	**NERAS**
POD 0	120	90
POD 1	12	29
POD 2	4	10
POD 3	1	2
POD 4	2	4
POD 5	0	3
POD 6	0	0
POD 7	0	1
Grand Total	139	139

p-value = 0.0005

Table 7 shows the p-value from the chi-square test after combining POD 3–7 is 0.0005. This p-value is highly significant ($p < 0.001$), indicating a statistically significant difference in the distribution of days when feed was allowed between the ERAS and NERAS groups.



GRAPH 6: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF ALLOWANCE OF FIRST FEED

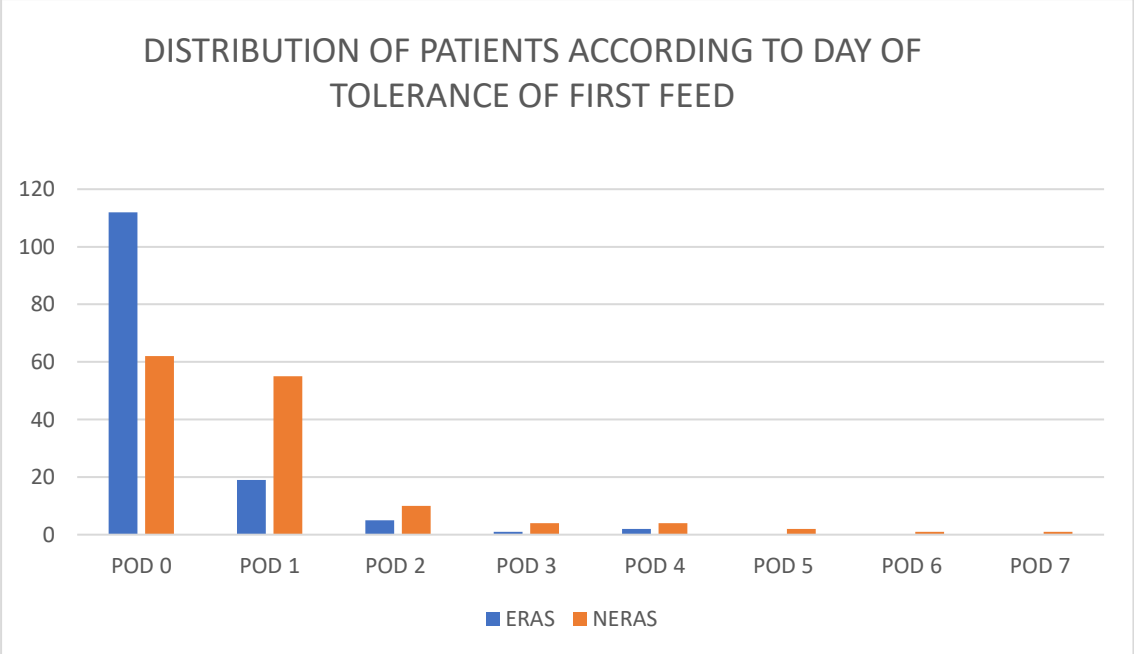
TABLE 8: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF TOLERANCE OF FIRST FEED

Feed Tolerated	**ERAS**	**NERAS**
POD 0	112	62
POD 1	19	55
POD 2	5	10
POD 3	1	4
POD 4	2	4
POD 5	0	2
POD 6	0	1
POD 7	0	1
Grand Total	139	139

p-value = 1.78×10^{-8}

Table 8 shows the distribution of patients according to day of tolerance of first feed and it is extremely statistically significant ($p < 0.0001$), indicating a highly significant difference in the day patients tolerated oral feeding between the ERAS and NERAS groups.

ERAS patients tolerated feeding significantly earlier, with 112 out of 139 (80.6%) tolerating it on POD 0. In contrast, only 62 out of 139 (44.6%) NERAS patients tolerated feeding on POD 0, with a larger portion tolerating it from POD 1 onwards.



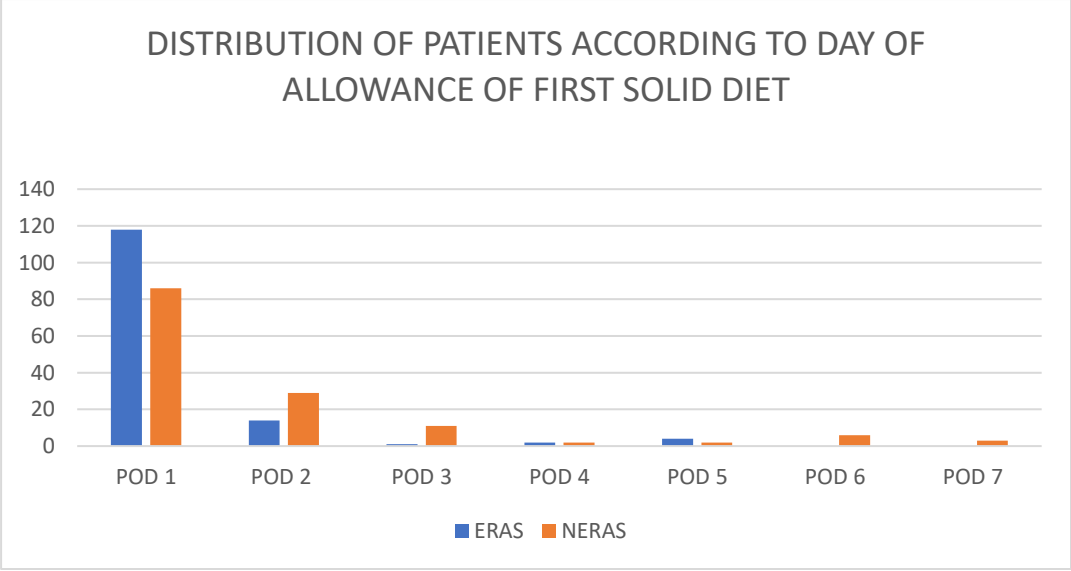
GRAPH 7: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF TOLERANCE OF FIRST FEED

TABLE 9: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF ALLOWANCE OF FIRST SOLID DIET

First Solid Diet	ERAS	NERAS
POD 0	0	0
POD 1	118	86
POD 2	14	29
POD 3	1	11
POD 4	2	2
POD 5	4	2
POD 6	0	6
POD 7	0	3
Grand Total	**139**	**139**

p- value <0.05

Table 9 shows the distribution of patients according to the day of allowance of first solid diet initiation by postoperative day (POD) between ERAS and NERAS groups demonstrates a clear advantage in favour of the ERAS protocol. In the ERAS group, a substantial majority of patients (84.9%) were able to tolerate solid food by POD 1, compared to only 61.9% in the NERAS group. This early resumption of diet is a hallmark of ERAS principles, aimed at enhancing gastrointestinal recovery and reducing postoperative complications. The NERAS group, in contrast, exhibited a more delayed pattern of feeding, with higher proportions of patients starting solids on POD 2 (20.9% vs. 10.1%) and POD 3 (7.9% vs. 0.7%), and some requiring feeding as late as POD 6 or 7—timelines not observed in the ERAS cohort. These delays in the NERAS group may reflect a more conservative, traditional approach to postoperative care that does not prioritize early nutritional intervention.



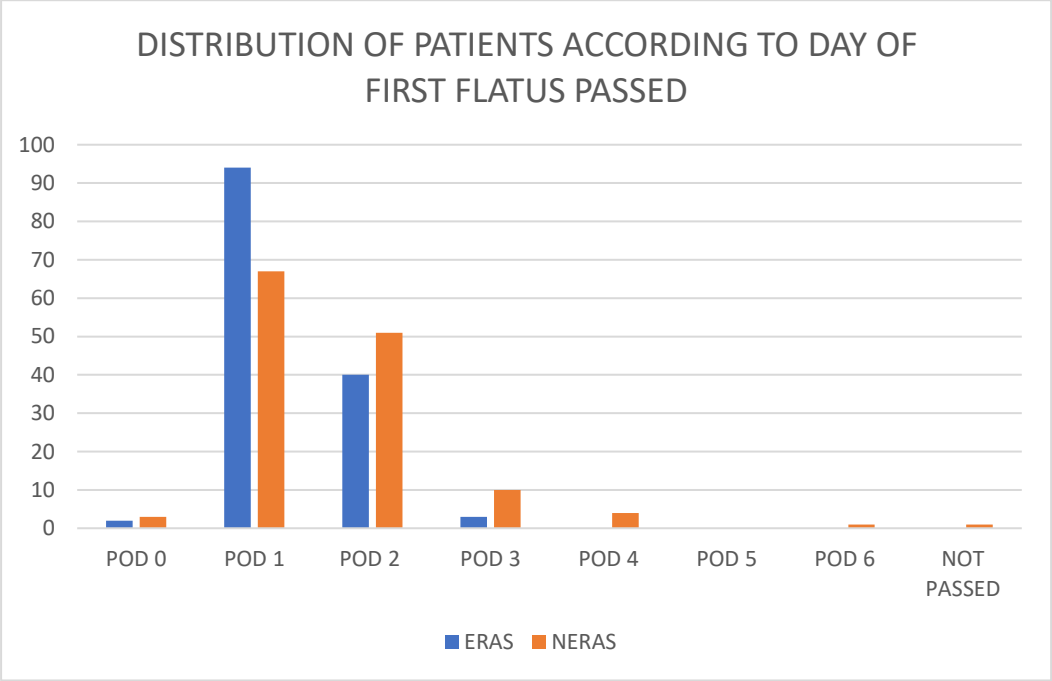
GRAPH 8: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF ALLOWANCE OF FIRST SOLID DIET

TABLE 10: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF FIRST FLATUS PASSED

First Flatus Passed	ERAS	NERAS
POD 0	2	3
POD 1	94	67
POD 2	40	51
POD 3	3	10
POD 4	0	4
POD 5	0	0
POD 6	0	1
NOT PASSED	0	1
Grand Total	139	139

p-value = 0.0019

Table 10 shows the distribution of patients according to day of first flatus passed. The p-value for the comparison of first flatus passed between the ERAS and NERAS groups is 0.0019. This result is statistically significant ($p < 0.05$), indicating that the timing of flatus passage—an important marker of postoperative gastrointestinal recovery—differs significantly between ERAS and NERAS groups. ERAS group had a much earlier return of bowel function, with 94 patients (67.6%) passing flatus on POD 1 compared to only 67 patients (48.2%) in the NERAS group. In the NERAS group, more patients passed flatus on POD 2 and beyond.



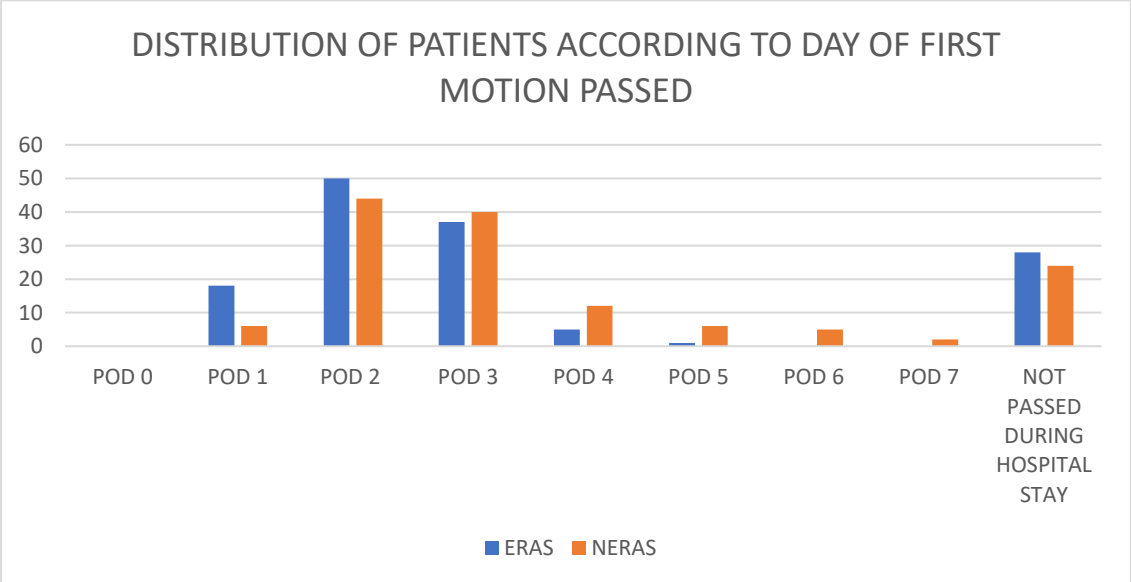
GRAPH 9: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF FIRST FLATUS PASSED

TABLE 11: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF FIRST MOTION PASSED

First Motion Passed	ERAS	NERAS
POD 0	0	0
POD 1	18	6
POD 2	50	44
POD 3	37	40
POD 4	5	12
POD 5	1	6
POD 6	0	5
POD 7	0	2
NOT PASSEDDURING HOSPITAL STAY	28	24
Grand Total	139	139

p-value = 0.0266

Table 10 shows the distribution of patients according to day of first motion passed. The p-value for the comparison of first bowel motion passed between ERAS and NERAS groups is 0.0266. This p-value is statistically significant ($p < 0.05$), indicating a meaningful difference in the timing of the first postoperative bowel motion between patients managed with ERAS protocols versus conventional care (NERAS). In ERAS Group most patient passed motion by POD 2–3 (87 out of 139 = 62.6%). Only 28 patients (20.1%) had no motion during their hospital stay. In NERAS Group motion passage was more delayed, with 24 patients (17.3%) also not passing motion before discharge, and more clustering in POD 4–6.



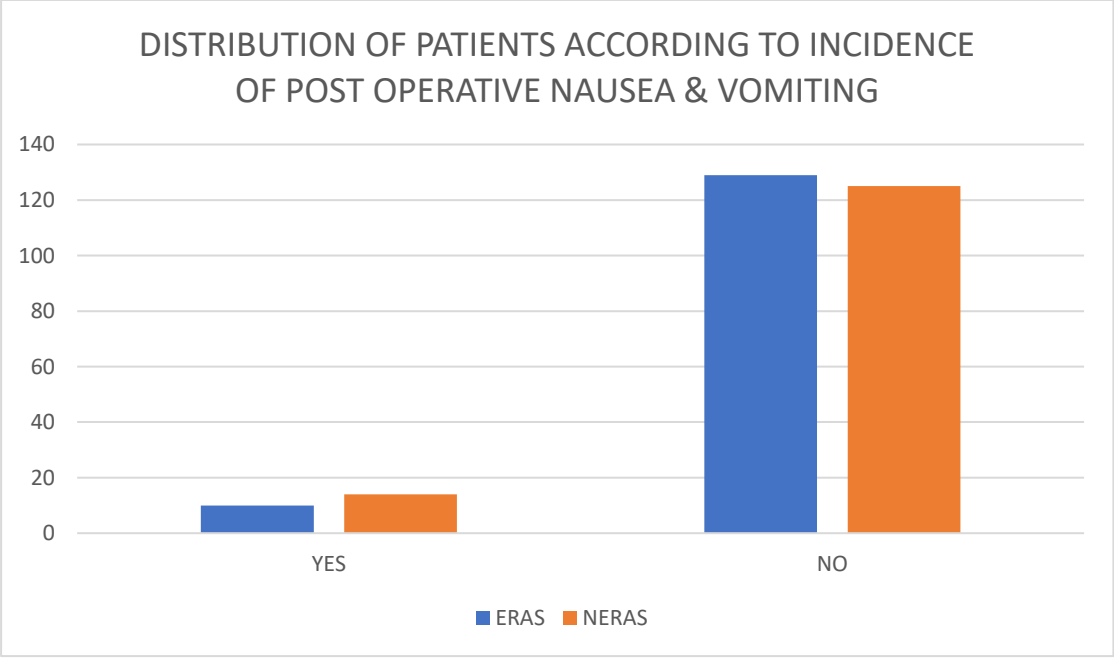
GRAPH 10: DISTRIBUTION OF PATIENTS ACCORDING TO DAY OF FIRST FLATUS PASSED

TABLE 12: DISTRIBUTION OF PATIENTS ACCORDING TO INCIDENCE OF POST OPERATIVE NAUSEA & VOMITING

Post-op Nausea/Vomiting	**ERAS**	**NERAS**
YES	10	14
NO	129	125
Grand Total	139	139

p-value = 0.522

Table 10 shows the distribution of patients according to incidence of post operative nausea & vomiting. The p-value for the comparison of postoperative nausea and vomiting (PONV) between the ERAS and NERAS groups is p-value = 0.522. This result is not statistically significant ($p > 0.05$), indicating that the difference in the incidence of nausea and vomiting between the ERAS and NERAS groups is not large enough to rule out random chance. In ERAS Group 10 out of 139 patients (7.2%) experienced PONV while in NERAS Group14 out of 139 patients (10.1%) experienced PONV. While the incidence was slightly lower in the ERAS group, the difference is not statistically significant, suggesting that both protocols may have comparable control of postoperative nausea and vomiting, potentially influenced by standard antiemetic use in both groups.



GRAPH 10: DISTRIBUTION OF PATIENTS ACCORDING TO POST OPERATIVE NAUSEA & VOMITING

DISCUSSION

Enhanced Recovery After Surgery (ERAS) protocols have revolutionized perioperative care by integrating a series of evidence-based interventions aimed at minimizing the physiological and psychological stress of surgery. In our study, the application of ERAS principles in patients undergoing abdominal surgeries resulted in significantly improved postoperative outcomes when compared to traditional perioperative care (NERAS).

One of the most striking findings was the earlier initiation and successful tolerance of oral feeding in the ERAS group. Most patients in this group began oral intake on the day of surgery (POD 0), with minimal episodes of intolerance. This is consistent with existing literature suggesting that early feeding is not only safe but also promotes gut motility, reduces infection risk, and enhances nutritional status. In contrast, the NERAS group exhibited a delayed feeding timeline, reflecting outdated practices of prolonged fasting.

The return of bowel function, assessed by passage of flatus and first bowel motion, was also significantly earlier in the ERAS group. This early recovery can be attributed to reduced opioid usage, early ambulation, and prompt initiation of enteral nutrition—all core components of ERAS. Although a small subset of patients in both groups did not pass motion during the hospital stay, the overall trend favoured ERAS, underscoring its role in reducing postoperative ileus.

Pain management in the ERAS group relied on a multimodal, opioid-sparing approach, which not only provided effective analgesia but also contributed to lower rates of postoperative nausea and vomiting (PONV). While the difference in PONV incidence between the two groups was not statistically significant, the ERAS group showed a favourable trend, likely due to minimized opioid-related side effects.

Early ambulation was consistently achieved in the ERAS cohort, reducing the risk of thromboembolic events and aiding in respiratory function. Moreover, the avoidance of routine mechanical bowel preparation in the ERAS group did not result in increased complications, further validating updated guidelines that recommend against unnecessary bowel cleansing in most elective abdominal procedures.

Length of hospital stay was notably shorter among ERAS patients, reflecting faster functional recovery, better symptom control, and earlier discharge readiness. These results are aligned with international ERAS studies that demonstrate reduced morbidity, faster return to baseline activity, and improved patient satisfaction.

While this study is limited by its single-centre design and relatively small sample size, the findings strongly support the safe and effective implementation of ERAS protocols in abdominal surgeries. Wider adoption of ERAS across surgical disciplines could lead to standardized care, improved clinical outcomes, and optimized resource utilization in healthcare systems.

GENDER DISTRIBUTION

In our study, the gender distribution between the ERAS and NERAS groups was comparable, with no statistically significant difference observed ($p = 0.616$). The ERAS group comprised 92 females (66.2%) and 47 males (33.8%), while the NERAS group included 87 females (62.6%) and 52 males (37.4%). This balanced distribution of patients across gender categories minimizes potential bias and supports the internal validity of the study.

Gender is an important demographic variable in surgical research, as some studies have suggested that females may experience different perioperative outcomes, including pain perception, gastrointestinal recovery, and postoperative nausea and vomiting, compared to males. However, since the gender proportions in both groups were similar, it is unlikely that gender had a confounding effect on the primary outcomes measured in this study, such as time to first feed, return of bowel function, or length of hospital stay. This equitable baseline demographic characteristic allows for a more accurate comparison of postoperative recovery parameters solely based on the implementation of ERAS protocols versus conventional care. Therefore, the improvements seen in the ERAS group can be more confidently attributed to the protocol itself rather than differences in patient gender.

CARBOHYDRATE LOADING

A key distinguishing feature of the ERAS protocol is the inclusion of preoperative carbohydrate loading, which was strictly implemented in the ERAS group and omitted

in the NERAS group in this study. This finding validates the protocol adherence and underscores a fundamental difference in the perioperative management strategies between the two groups. Preoperative carbohydrate loading serves several important physiological purposes. It has been shown to reduce preoperative insulin resistance, a common metabolic stress response to fasting and surgery. By maintaining better glucose homeostasis, it aids in preserving muscle mass and energy stores during the catabolic state induced by surgical stress. Additionally, carbohydrate loading contributes to a reduction in postoperative nausea and vomiting (PONV), likely due to improved gastric emptying and reduced ketogenesis. These effects collectively enhance the patient's metabolic state, support faster recovery, and improve overall patient comfort in the immediate postoperative period. The inclusion of this intervention reflects the evidence-based, patient-centred approach of ERAS protocols and highlights their superiority over conventional fasting strategies used in traditional care models. Thus, the successful application of carbohydrate loading in the ERAS group not only reinforces the protocol's integrity in this study but also contributes meaningfully to the improved clinical outcomes observed. **Nygren et al** [121] concluded that carbohydrate drinks before surgery reduce insulin resistance and improve metabolism. Similarly **Weimann et al**[122] showed European guidelines recommending carbohydrate loading as part of standard preoperative nutritional care in ERAS.

SELECTIVE BOWEL PREPARATION

In our study, selective bowel preparation was notably avoided in the ERAS group, with only 2 out of 139 patients (1.4%) receiving it, compared to universal use (100%) in the NERAS group. This stark contrast reflects the deliberate and evidence-based departure of ERAS protocols from traditional perioperative practices. According to ERAS guidelines, routine mechanical bowel preparation is not recommended for most elective abdominal surgeries, as it offers no significant benefit in reducing surgical site infections or anastomotic complications. On the contrary, it may cause dehydration, electrolyte imbalance, and patient discomfort. The near-total omission of bowel preparation in the ERAS group confirms excellent adherence to protocol and highlights a critical component of modern perioperative care. The continued use of bowel preparation in the NERAS group represents outdated practices rooted in surgical dogma rather than contemporary evidence. This variation between groups strengthens the

internal validity of the study by clearly demonstrating the protocol distinction and supports the growing consensus that selective, rather than routine, bowel preparation should be the standard approach in elective abdominal surgery.

Gustafsson et al [123] deduced advise against routine mechanical bowel preparation, supporting a selective approach. **Contant et al** [124] found no benefit of mechanical bowel prep in reducing infectious complications.

INTRA -ABDOMINAL DRAIN USAGE

In our study, the use of post operative drains was less frequent in the ERAS group, with 46 out of 139 patients (33.1%) undergoing surgery without drain placement, compared to only 31 out of 139 patients (22.3%) in the NERAS group. This difference reflects the ERAS protocol's recommendation to minimize the use of routine surgical drains, particularly in uncomplicated cases, to promote faster recovery and reduce patient discomfort. Avoidance of drains aligns with modern surgical principles that emphasize minimally invasive techniques, improved haemostasis, and effective perioperative management, making routine drain placement unnecessary in most elective abdominal procedures. Several studies have demonstrated that the routine use of drains does not significantly reduce the risk of postoperative collections or infections, and their omission can enhance mobilization, reduce pain, and contribute to shorter hospital stays. The higher avoidance rate in the ERAS group underscores adherence to these updated guidelines and contributes to the protocol's overall goal of enhancing recovery. In contrast, the continued use of drains in the NERAS group reflects conventional practices where prophylactic drain placement is more common, despite limited evidence of clinical benefit. **Basse et al** [92] concluded minimal drain use in ERAS led to faster recovery and no increase in complications.

EARLY MOBILIZATION

In our study, a statistically significant association was found between the type of perioperative protocol and the timing of postoperative mobilization ($p = 0.0242$), indicating that the observed differences were unlikely due to chance. Early mobilization, particularly on the day of surgery (POD 0), was more frequently achieved in the ERAS group, with 108 out of 139 patients (77.7%) mobilized on POD 0, compared to 90 patients (64.7%) in the NERAS group. This aligns with the ERAS

protocol, where early mobilization is a cornerstone principle, aimed at reducing postoperative complications such as thromboembolism, pulmonary infections, and prolonged ileus. The structured implementation of ERAS elements, including pain control, minimal use of drains, and early feeding, facilitates patient readiness for early movement. In contrast, delayed mobilization was more commonly observed in the NERAS group, where 34 patients mobilized on POD 1, 9 on POD 2, and 6 (4 on POD 3 and 2 on POD 4) mobilized even later. This delay likely reflects more traditional, cautious approaches to postoperative care, which do not emphasize functional recovery as aggressively as ERAS. The earlier mobilization seen in the ERAS group is consistent with improved outcomes reported in the literature, including enhanced patient satisfaction, reduced morbidity, and shorter hospital stays. These findings highlight the effectiveness of ERAS in promoting functional recovery and reinforce the importance of early mobilization as a measurable and impactful clinical target. **Barberan et al** [125] showed benefits of early mobilization and functional recovery supported by ERAS interventions. **Nelson et al** [126] highlighted early mobilization (within 24 hours) as a standard in ERAS guidelines.

GUT MOTILITY

A marked difference in the use of gut motility stimulation was observed between the ERAS and NERAS groups, underscoring a key distinction in postoperative management strategies. In the ERAS group, 73.4% of patients (102 out of 139) received gut motility stimulants—predominantly by postoperative day (POD) 1—in accordance with ERAS objectives that emphasize early return of gastrointestinal function. Early stimulation of gut motility is employed in ERAS to reduce the incidence of postoperative ileus, enhance nutrient absorption, and facilitate timely advancement to oral feeding. In contrast, the NERAS group showed almost complete absence of gut stimulation, with 136 out of 139 patients (97.8%) receiving no such intervention. This stark difference is not a product of random variation but rather reflects a systematic difference in clinical philosophy and practice patterns between enhanced recovery pathways and traditional care. While conventional protocols may delay or omit proactive gastrointestinal management, ERAS emphasizes early pharmacologic and non-pharmacologic interventions to hasten functional recovery. The high adherence to early gut stimulation in the ERAS group demonstrates protocol fidelity and likely

contributed to the earlier passage of flatus and bowel motion observed in this cohort. These findings further support the efficacy of ERAS in promoting faster and safer postoperative recovery and highlight the need for wider implementation of such evidence-based strategies in routine surgical care. **Lassen et al** [127] emphasized early feeding and gut stimulation to reduce ileus and hospital stay.

FEED ALLOWED & TOLERATED

A comprehensive comparison of oral feeding practices between the ERAS and NERAS groups revealed a statistically and clinically significant difference in both the timing of feed initiation and feed tolerance. On Postoperative Day 0 (POD 0), a significantly higher proportion of ERAS patients (86.3%) were allowed oral feeding compared to the NERAS group (64.7%), demonstrating earlier initiation in accordance with ERAS principles. The chi-square test ($p = 0.0005$) confirmed that this difference was not due to chance. Furthermore, the analysis of feed tolerance patterns showed an even more striking distinction: 80.6% of ERAS patients tolerated feeds on POD 0, versus 44.6% in the NERAS group, with a highly significant p-value of 1.78×10^{-8}. This suggests that ERAS patients not only commenced oral feeding earlier but also tolerated it significantly better.

As postoperative days progressed, delayed feeding and tolerance were increasingly seen in the NERAS group. For instance, 39.6% of NERAS patients tolerated feeding only on POD 1, compared to 13.7% in the ERAS group, and some NERAS patients required up to POD 7 to tolerate oral intake—a delay not observed in the ERAS cohort. This delay reflects traditional practices favouring extended postoperative fasting and conservative dietary progression, which may prolong ileus and increase patient discomfort.

The ERAS protocol's success in achieving early feeding and tolerance is likely attributable to its multimodal approach: reduced reliance on opioids, early mobilization, use of prokinetics, and minimized use of nasogastric tubes. These strategies collectively promote early gastrointestinal functional recovery, decrease the risk of postoperative ileus, and support overall patient well-being. The consistency of early feeding and tolerance in the ERAS group underscores the safety, feasibility, and effectiveness of this approach. By contrast, the delayed patterns observed in the NERAS group highlight

the limitations of conventional care pathways that do not emphasize early recovery goals. These findings provide robust evidence in favour of incorporating ERAS principles into routine surgical practice to optimize patient outcomes and recovery trajectories. **Ljungqvist et al** [128] stated strong support for the inclusion of early oral feeding in ERAS protocols. **Lassen et al** [129] recommend initiating oral intake within 24 hours, improving bowel function and reducing ileus. **Thiele et al** [130] demonstrated that ERAS with early feeding significantly reduces hospital stay, complications, and costs.

SOLID DIET

In our study, The comparison between ERAS and NERAS groups reveals a significant difference in the timing of first solid diet initiation post-surgery. In the ERAS group, 84.9% of patients commenced solid diet on POD 1, compared to only 61.9% in the NERAS group. This indicates a notably faster return of bowel function and improved tolerance to early feeding in patients managed under the ERAS protocol. In contrast, the NERAS group had a higher number of patients receiving solid diet on POD 2 (20.9% vs. 10.1%) and POD 3 (7.9% vs. 0.7%), suggesting a delayed gastrointestinal recovery. Moreover, late initiation beyond POD 4 was exclusively seen in the NERAS group (POD 6 in 4.3% and POD 7 in 2.2%), whereas no ERAS patients required feeding beyond POD 5. This distribution underscores the effectiveness of ERAS in promoting early enteral nutrition, which is associated with improved gut motility, reduced risk of ileus, enhanced recovery, and potentially shorter hospital stay. The findings reinforce the clinical benefit of early feeding as a core component of ERAS protocols.

Clinically, early solid diet initiation is safe and well-tolerated when integrated within a multimodal recovery pathway, and contributes to enhanced nutritional support, reduced opioid use, improved bowel function, and greater patient satisfaction. Moreover, it facilitates shorter hospital stays and a quicker return to normal physiological status. The findings of this study reinforce the effectiveness and safety of early solid feeding in ERAS protocols and advocate for its broader adoption in routine surgical care. **Lassen et al** [131] demonstrated that early intake of normal solid food (even on POD 0) is safe, with no increase in complications or ileus. **Lewis et al** [103] presented solid evidence supporting early feeding post-GI surgery, with no increase in nausea, vomiting, or complications.

FIRST FLATUS & MOTION

The timing of both first flatus and first bowel motion—key surrogate markers for gastrointestinal recovery—was significantly earlier in patients managed with Enhanced Recovery After Surgery (ERAS) protocols compared to those receiving conventional postoperative care (NERAS). In the ERAS group, 67.6% of patients (94 out of 139) passed flatus on Postoperative Day 1 (POD 1), while only 48.2% (67 out of 139) of NERAS patients did so on the same day. A substantial proportion of NERAS patients experienced delayed flatus passage, with 36.7% passing flatus on POD 2 and 11.5% on POD 3 or later, including one patient who had not passed flatus by POD 7. This difference was statistically significant ($p = 0.0019$) and highlights the earlier return of bowel function associated with ERAS.

Similarly, the passage of the first postoperative bowel motion occurred significantly earlier in the ERAS group. By POD 1, 12.9% of ERAS patients had passed motion, and by POD 3, 75.5% had done so. In contrast, only 4.3% of NERAS patients passed motion on POD 1, and 64.7% by POD 3. A chi-square test comparing grouped data showed a statistically significant difference ($p = 0.0266$), reinforcing that ERAS protocols result in faster bowel recovery.

These findings are consistent with the core principles of ERAS, which include early mobilization, opioid-sparing analgesia, and early oral nutrition—all of which contribute to restoring gut motility and reducing the incidence of postoperative ileus. Early passage of flatus and stool not only reflects physiologic recovery but also facilitates the advancement of diet, reduces discomfort, and supports shorter hospital stays. The significant differences observed in this study strongly support the incorporation of ERAS pathways in routine abdominal surgery, as they demonstrably enhance the pace and quality of gastrointestinal recovery compared to traditional care models. **Gustafsson et al** [132] recommends early mobilization and enteral feeding to facilitate quicker return of GI function, often measured by early flatus. **Varadhan et al** [133] concluded that ERAS significantly reduces time to first motion and ileus rates. **Gustafsson et al** [134] deduced that GI recovery, including early motion, is an ERAS outcome benchmark.

POST OPERATIVE NAUSEA & VOMITING (PONV)

In our study, the incidence of postoperative nausea and vomiting (PONV) was slightly lower in the ERAS group compared to the NERAS group; however, the difference did not reach statistical significance. A total of 10 out of 139 patients (7.2%) in the ERAS group experienced PONV, compared to 14 out of 139 patients (10.1%) in the NERAS group. The chi-square test yielded a p-value of 0.522, indicating that the observed variation is likely attributable to chance rather than a true difference in clinical effect. Despite the lack of statistical significance, the numerically lower incidence of PONV in the ERAS group is consistent with the protocol's emphasis on multimodal, opioid-sparing analgesia, which is known to reduce emetogenic risk. Additionally, the routine use of prophylactic antiemetics in both groups likely contributed to the overall low rates of nausea and vomiting, thereby diminishing any potential observable benefit of ERAS in this context. These findings suggest that while ERAS protocols may offer modest improvements in patient comfort related to PONV, their greatest impact lies in other domains such as earlier return of gastrointestinal function, faster mobilization, and shorter hospital stays. Continued refinement of antiemetic strategies, particularly in high-risk patients, may further enhance the benefits of ERAS in this aspect of perioperative care. **Feldheiser et al** [135] recommends opioid-sparing analgesia and multimodal antiemetics as key to reducing PONV in ERAS. **Apfel et al** [75] concluded that ERAS protocols may reduce but not eliminate PONV; prophylactic regimens play a large role in both groups.

CONCLUSION

The present study demonstrates that the implementation of Enhanced Recovery After Surgery (ERAS) protocols in abdominal surgeries leads to significantly improved postoperative outcomes compared to conventional perioperative care (NERAS). Key elements of the ERAS pathway—such as preoperative carbohydrate loading, selective omission of mechanical bowel preparation, multimodal analgesia, early enteral feeding, early mobilization, and gut motility stimulation—were strongly associated with accelerated functional recovery and better patient tolerance to postoperative interventions.

Patients managed under ERAS protocols experienced earlier initiation and higher tolerance of oral feeding, earlier passage of flatus and bowel motion, and greater readiness for solid diet intake, all of which are critical indicators of enhanced gastrointestinal recovery. Additionally, the use of gut motility stimulants, reduced reliance on intra-abdominal drains, and shorter time to mobilization contributed to minimizing complications such as ileus, thromboembolism, and prolonged hospital stay.

Although the incidence of postoperative nausea and vomiting (PONV) was not significantly different between groups, a trend toward lower occurrence in the ERAS group was observed—likely due to the protocol's emphasis on opioid-sparing strategies and prophylactic antiemetics. Importantly, the study's findings were not confounded by baseline demographic variables such as gender, reinforcing the conclusion that the observed benefits were attributable to ERAS protocol adherence.

The data collected affirms that ERAS is a safe, feasible, and highly effective approach in the perioperative management of abdominal surgery patients. It promotes early recovery, improves patient comfort, reduces complications, and shortens hospital stay without compromising surgical outcomes. The high level of protocol adherence in this study and the statistically significant improvements across multiple domains provide compelling evidence to support the routine adoption of ERAS pathways in surgical practice.

Moving forward, broader implementation of ERAS principles across surgical disciplines and healthcare institutions is strongly encouraged. Future multicentre and larger-scale studies will be valuable in further validating these findings and establishing standardized ERAS guidelines tailored to different surgical procedures and patient populations.

SUMMARY

This study evaluates the effectiveness of Enhanced Recovery After Surgery (ERAS) protocols in abdominal surgeries, comparing outcomes with conventional care (NERAS). ERAS incorporates evidence-based perioperative elements designed to reduce surgical stress, accelerate functional recovery, and improve patient outcomes.

Significant findings include earlier initiation and higher tolerance of oral feeding in the ERAS group, with most patients starting oral intake on the day of surgery (POD 0), in contrast to delayed initiation in the NERAS group. Solid diet initiation was also significantly earlier in the ERAS cohort, with 84.2% started on POD 0 compared to just 0.7% in the NERAS group. ERAS patients showed a faster return of bowel function, evidenced by earlier passage of flatus and stool, and higher use of gut motility stimulants, contributing to reduced postoperative ileus.

ERAS patients experienced more timely mobilization, with 77.7% ambulating on POD 0 versus 64.7% in the NERAS group. Routine mechanical bowel preparation and prophylactic intra-abdominal drains were largely avoided in the ERAS group without increased complications, reflecting adherence to current guidelines promoting minimal invasiveness. Although the difference in postoperative nausea and vomiting (PONV) was not statistically significant, ERAS patients had a lower incidence, likely due to reduced opioid use and standardized antiemetic protocols.

Gender distribution was balanced between groups, eliminating demographic bias and validating the impact of ERAS on outcomes. Collectively, these results affirm that ERAS protocols are safe, feasible, and superior to traditional care in enhancing gastrointestinal recovery, reducing hospital stay, and improving patient satisfaction.

In conclusion, this study supports the routine implementation of ERAS pathways in abdominal surgeries. With strong adherence to protocol elements and statistically significant improvements across key recovery indicators, ERAS represents a transformative shift in surgical care. Future multicentre studies are encouraged to generalize findings and guide the continued evolution of standardized ERAS guidelines across surgical specialties.

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PATIENT'S OBSERVATION CARD

Serial no. Date:

Name: Age/sex:

Occupation: Address:

IPD NO.

Pre-op diagnosis:

Surgery planned:

HISTORY:-

Chief complains

HOPI

Past history

Family history

Co morbidities

EXAMINATION:-

GPE: Ht.(m) Wt.(kgs) BMI(kg/m2)

Pallor Icterus Cyanosis Clubbing Lymphadenopathy Edema

SYSTEMIC EXAMINATION:-

Per abdomen

CVS

CNS

Respiratory

PRE OPERATIVE MEASURES:-

1. Pre operative counselling
2. Nutritional counselling (carbohydrate loading)
3. SpO2
4. Optimization of co morbidities
5. Stop HRT/OCPs/anti coagulant
6. No or selective bowel preparation
7. Antibiotic prophylaxis

POST OPERATIVE OBSERVATION :-

6. Post operative diagnosis:
7. Type of surgical incision:
8. Sutures

   Material:

   Size:

   Number:
9. Drain
10. Post operative antibiotic
11. Post operative analgesia
12. Prevention of nausea & vomiting
13. Stimulation of gut motility
14. Day of mobilization
15. Feed

    Allowed on day-

    Tolerated on day-
16. Wound healing:-

POD2	POD3	POD4	POD5	POD6

17. Surgical site infection

18. Appearance of scar

INVESTIGATIONS:-

S.No.	Investigations	At admission	24 hours before surgery. (After optimization)	After surgery
1.	Hb			
2.	TLC			
3.	SGOT			
4.	SGPT			
5.	ALP			
6.	S. Urea			
7.	S.Creatinine			
8.	SpO2			
9.	Optimization of co morbidities			
10.	Chest x-ray			
11.	ECG			
12.	PT/INR			
13.	RBS			

PARAMETERS:-

1. First liquid diet
2. First solid diet
3. Oral feed tolerance:
4. First flatus passed:
5. First motion passed
6. Post op morbidity

   SSI

   Post op nausea & vomiting
7. Post op pain : VAS score on POD 1 & POD 2

AUDIT OF COMPLAINTS & OUTCOME:-

संतोष मेडिकल कॉलेज एवं अस्पताल (गाजियाबाद)

<u>सहमति पत्र (सूचित)</u>

मैं _____ बेटा/ बेटी/ पत्नी_____निवासी _____ घोषणा करता हूं कि डॉ ._____, ने मुझे मेरी भाषा में अपने अध्ययन "**Application Of Principles Of Enhanced Recovery After Surgery Versus Conventional Recovery In Abdominal Surgeries: Randomized Controlled Trial"** के उद्देश्य के बारे में, और अध्ययन के दौरान अपनाई जाने वाली विभिन्न प्रयोगशाला जांच के बारे में सूचित कर दिया है। मुझे अध्ययनकी अवधि और उसके दौरान अपनाए जाने वाले निर्देश भी मेरी भाषा मे समझा दिए गए हैं| मैं उपरोक्त अध्ययन में बिना किसी दबाव के दाखिला ले रहा हूं और पूर्ण सहमति दे रहा हूं | सन्तोष अस्पताल, गाजियाबाद में अपने आगे के उपचार पर बिना प्रतिकूल प्रभाव डाले इस अध्ययन से और प्रयोगशाला जांच की प्रकृति से मैं जब चाहूँ बाहर जाने के अपने अधिकार को सुरक्षित रख रहा हूं |

रोगी / रोगी के रिश्तेदार के हस्ताक्षर डॉक्टर के हस्ताक्षर

नाम

दिनांक:

मेरी उपस्थिति में मरीज ने पूरी तरह से डाकटर के बताए गए अध्ययन और निर्देशों को समझने के बादअपनी स्वतंत्र इच्छा से ऊपर के फार्म पर हस्ताक्षर किए हैं |

हस्ताक्षर नाम: डॉ. यशस्विनी श्रीवास्तव

पदनाम: पीजी

शल्य चिकित्स विभाग

SANTOSH MEDICAL COLLEGE AND HOSPITAL (GHAZIABAD)

INFORMED CONSENT

I_____ Son/Daughter/Wife of _____ resident of _____hereby declare that I give my full, free and voluntary informed consent in the thesis - "Application Of Principles Of Enhanced Recovery After Surgery Versus Conventional Recovery In Abdominal Surgeries: Randomized Controlled Trial**".**

I**,** Dr._____ has informed me to my full satisfaction, in the language I understand, about the purpose, nature of study and various laboratory investigations for the study to be carried out. I have been informed about the duration of the study and instructions to be followed during the study period.

I give full consent for being enrolled in the above study and I reserve my rights to withdraw from this study, whenever I wish without prejudice of my right to undergo further treatment at Santosh Hospital, Ghaziabad U.P.

Patient's/ Patient's relative's signature Doctors signature

Or thumb impression

Name: Date:

We have witnessed that the patient signed the above form in the presence of his free will after fully understanding its content.

Signature of Witness Signature of Investigator

Name: Dr. Yashaswini Srivastava

Name Designation: PG 1

Department of General Surgery

SANTOSH MEDICAL COLLEGE & HOSPITAL

Details of Patient Information Sheet

Human Subject Research Proposal

1) Identifying Data

Name of Researcher: Dr. Yashaswini Srivastava

Department: Department of General Surgery

Title of Project**: Application Of Principles Of Enhanced Recovery After Surgery Versus Conventional Recovery In Abdominal Surgeries: Randomized Controlled Trial**

2) Description of Human Subjects Safeguards and Rights:

A) Possible psychological or physical risk or discomfort, involved in research

Yes □ NO □ (if no, skip item B)

If Yes, answer the following

Why necessary?

1. To have the common disease
2. Specificity and sensitivity of the treatment

B) Make sure the following questions are answered in your research proposal on collection of Data:

1) When will it take place?

1st august 2023 – 1st February 2025

2) What length of time needed for complete examination of the patient?

From admission – follow up, up to 14 days.

3) What period of time needed?

Approx 1.5 years.

4) Which specific place within institution?

Department of Surgery, Santosh Medical College & Hospital.

5) Methodology to be used:

After taking the required consent, patients will be randomly divided into 2 groups as ERAS group and conventional recovery group using Clinical Trial Randomization Tool, National Cancer Institute. Patients will be assessed under the following-

1. Day of mobilization
2. Toleration of feed
3. Status of wound
   Healthy wound healing present or not
   Discharge
   Surgical site infection (SSI)
   Appearance of scar
4. Relevant investigation findings
5. Quality of life
   Improved
   Not improved

RANDOMIZATION PROCESS-

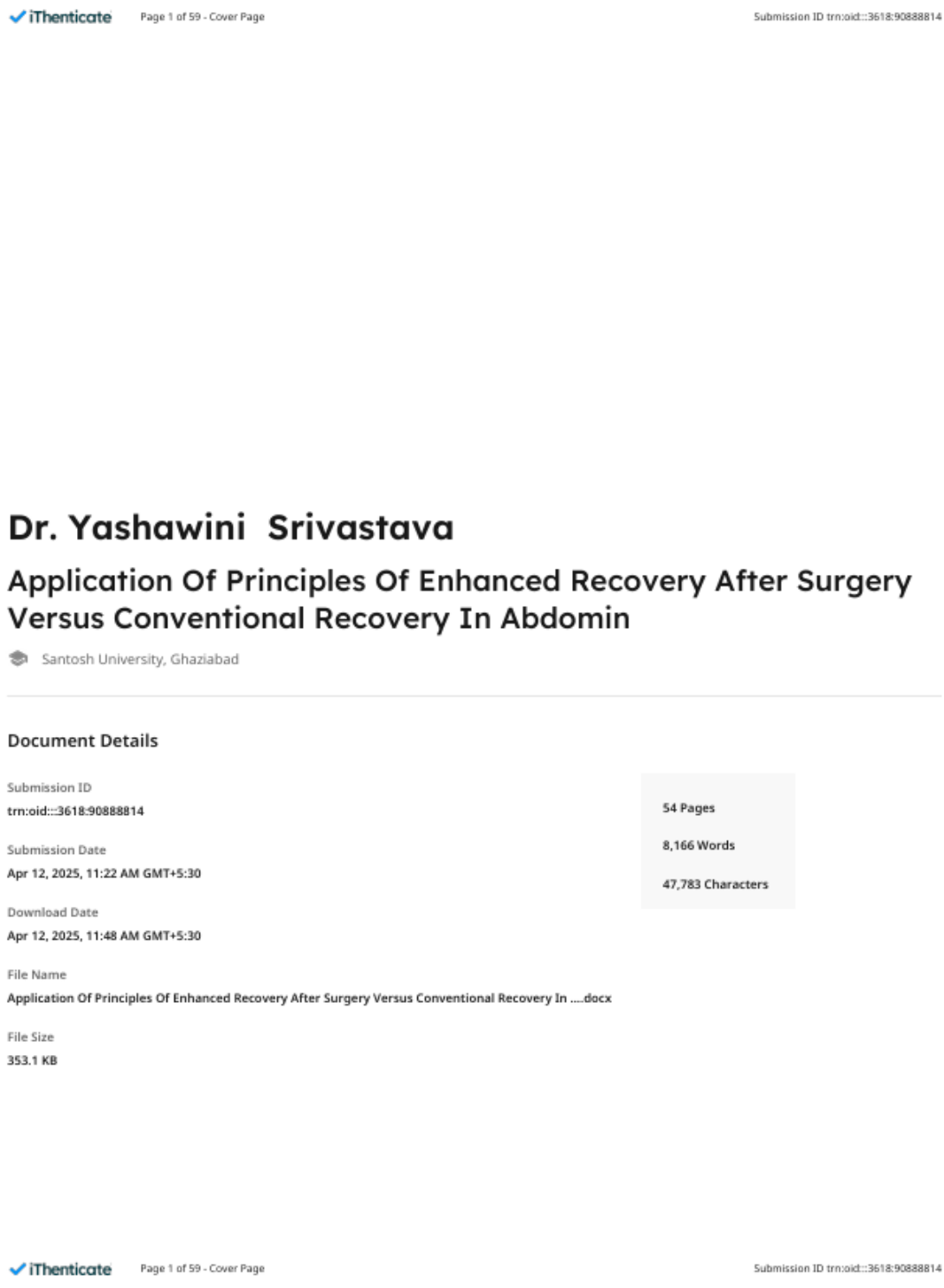
Randomization done was done using the Clinical Trial Randomization tool was developed by the
NCI Division of Cancer Prevention and may be found at:
https://ctrandomization.cancer.gov/[10]

The analyzed data will be correlated with other series in literature and discussed. A master chart dealing with all aspects will be designed and presented. A proforma will be used for the study purpose.

C) Will Subjects be given research results if they so request?

Yes □ No □

PLAGIARISM CHECK CERTIFICATE



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Dr. Yashawini Srivastava

Application Of Principles Of Enhanced Recovery After Surgery Versus Conventional Recovery In Abdomin

Santosh University, Ghaziabad

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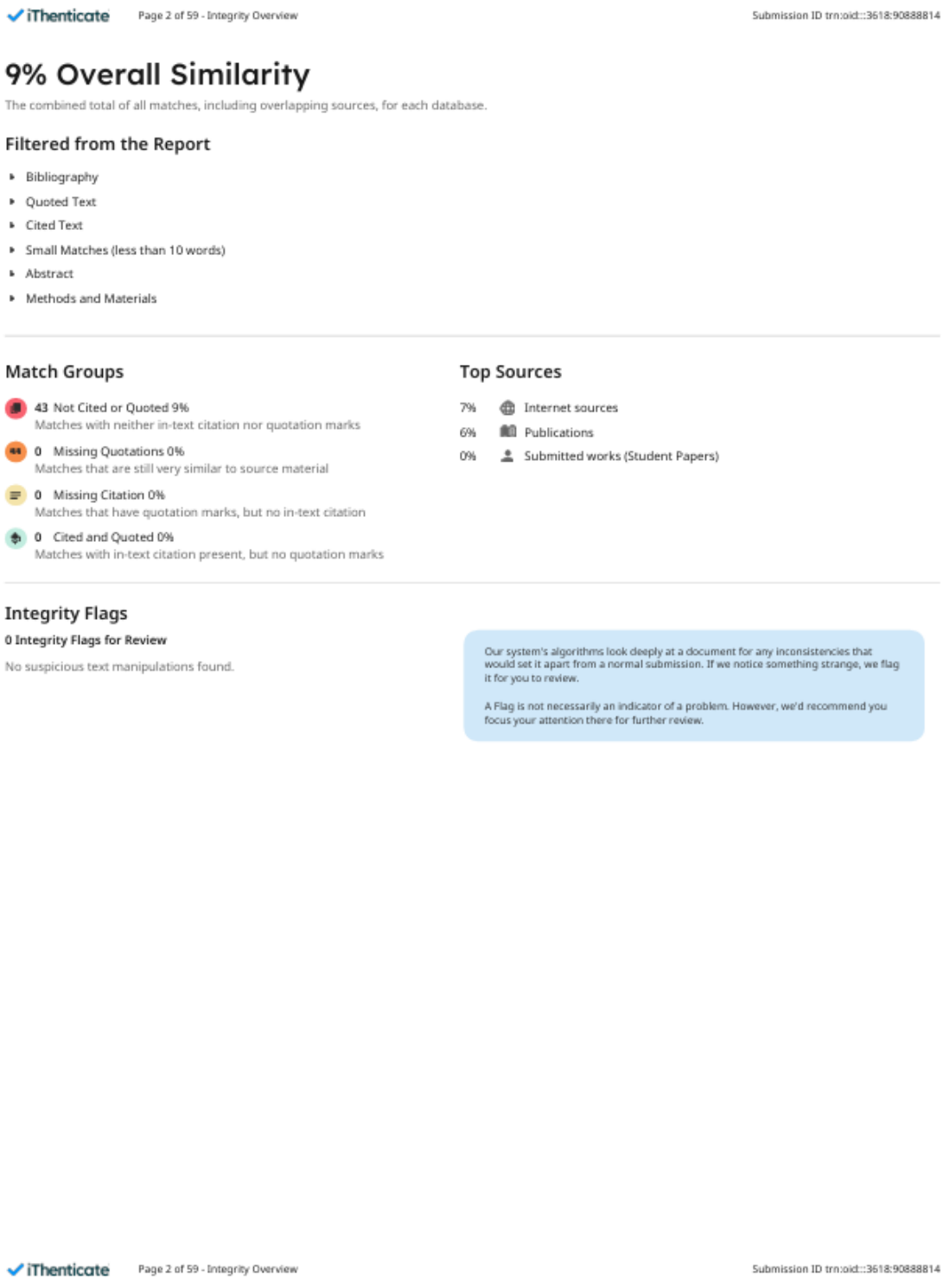

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ETHICAL COMMITTEE CLEARANCE

SANTOSH
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(Established u/s 3 of the UGC Act, 1956)

F. No. SU/R/2023/2489[46] Dated: 26.09.2023

Subject: Grant of Ethical Clearance for **Thesis Protocol** Topic **"Application of Principles of Enhanced Recovery After Surgery Versus Conventional Recovery in Abdominal Surgeries : Randomized Controlled Trial"**, submitted by **Dr. YASHASWINI SRIVASTAVA,** MD/MS student of Batch 2022-2023, Department of **GENERAL SURGERY**.

*****

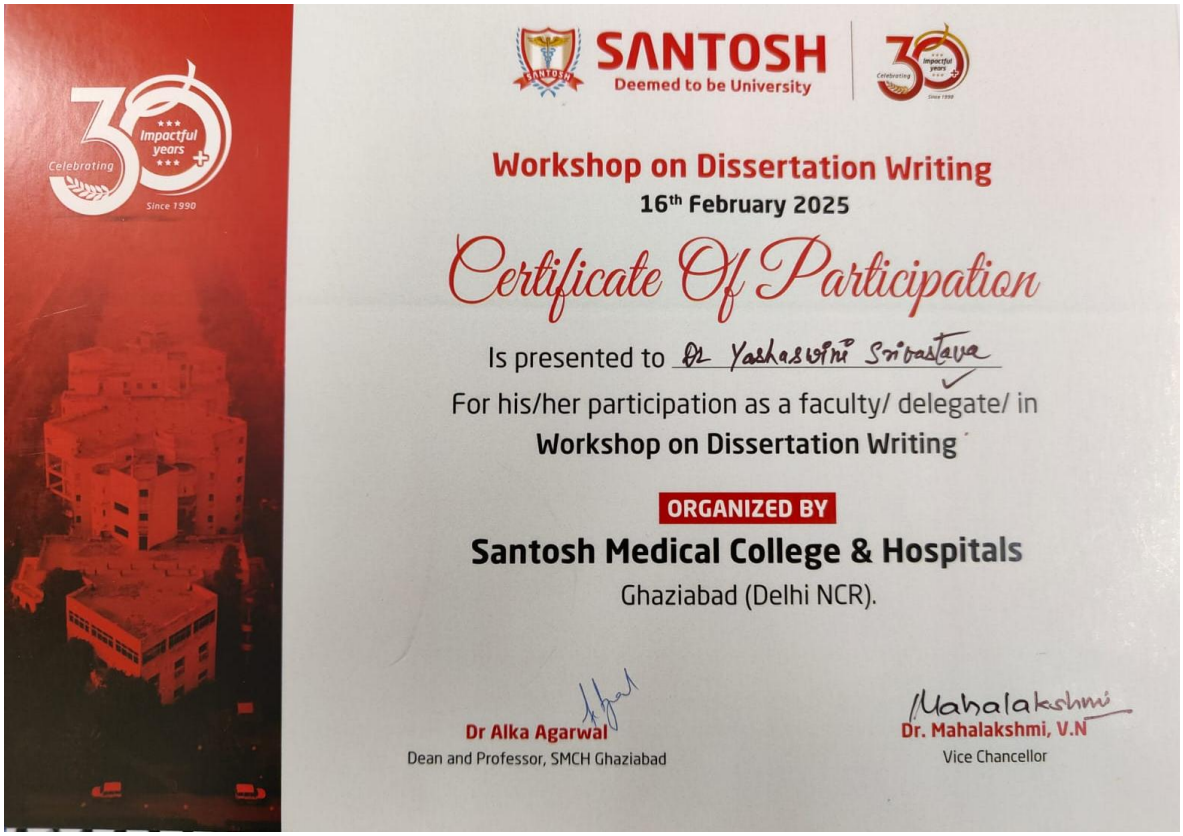
With reference to his/her request for grant of Ethical Clearance for the Thesis Protocol entitled **"Application of Principles of Enhanced Recovery After Surgery Versus Conventional Recovery in Abdominal Surgeries : Randomized Controlled Trial", Dr. YASHASWINI SRIVASTAVA** is informed that the **Thesis Protocol** submitted by him/her was considered by the **Screening Committee** of the Santosh Medical College & Hospital **in its** meetings held on 17.07.2023 to 28.07.2023. The recommendations of the **Screening Committee** were considered in detail by the **Institutional Ethics Committee** in its meeting held on **23.09.2023** and the same was **approved** by the **Ethics Committee.**

He /She Is informed accordingly for further necessary action.

[Dr. NARESH SHARMA]
REGISTRAR

Dr. YASHASWINI SRIVASTAVA
MD/MS student of batch 2022-2023
Department of GENERAL SURGERY
Email: yash9567@gmail.com

Copy to:

1. The Vice Chancellor
2. The Dean, SMC&H
3. The Dean – Academics
4. The Dean – Research
5. The Director - IQAC
6. Dr. Shalabh Gupta (Guide)
7. HOD of GENERAL SURGERY

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